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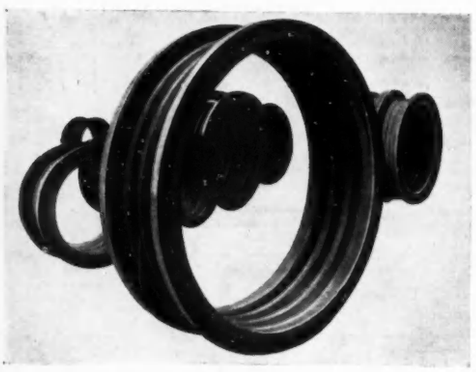

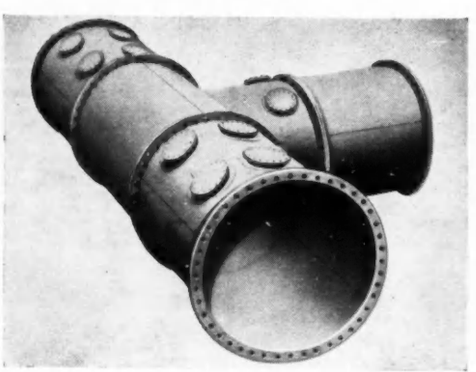

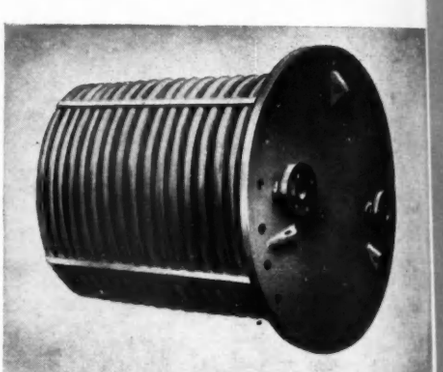

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ENGINEERING

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Grasp This Nettle

THE Victoria Tube is an imaginary underground railway in London, running north-east from Victoria and linking all London Transport's railway routes and many of British Railways' suburban and main lines. It was first imagined 30 years ago. Its construction was recommended as having "high priority" in 1949 by a committee appointed to examine the traffic needs of London. In 1955 the British Transport Commission obtained statutory powers to construct it from Victoria to Walthamstow, taking in Oxford Circus, Euston and Kings Cross *en route*.

At the Institution of Civil Engineers last week Mr. F. S. P. Turner, principal new works assistant of the London Transport Executive, presented a paper on the preliminary planning for the proposed tube, examining the project up to the stage of preparing detailed drawings. But the following day the Minister of Transport, in reply to a question in the House of Commons, shattered all hopes by saying that the Victoria Tube could not be constructed because the money could not be found from within the internal finances of the British Transport Commission. Mr. Turner had said that the project, excluding rolling stock, would cost £50 million. The Minister said he was looking to see if the money could be better spent on car parking facilities.

As proposed, the tube would provide a fifth underground route across London and make interchange connections with the four existing tubes: the Northern, Bakerloo, Piccadilly and Central. It would also provide a large dormitory with its first direct link with the centre of London. The existing tubes were built more than 50 years ago as independant railways by private enterprises. The routes were competitive and, originally, there was little intention that they should be interconnected, but opportunities were taken later to make connections underground. Though they were made at relatively low cost, these connections made travel in London appreciably smoother and quicker. Mr. Turner's proposals tackle the problem with great imagination and by making maximum use of the possibilities he has succeeded in providing platform interchange at several points along the route. The tube would cut by many minutes the daily journeys of many thousands of Londoners. At rush hour it would have a capacity of 32,000 passengers an hour—a conservative estimate making no allowance for the Londoners' ability to squeeze another commuter inside the closing doors.

At £50 million, the cost of the Victoria Tube and its full number of connections is not heavy in relation to the benefits it would bring. These benefits can be forecast fairly accurately, but no one can tell the Minister precisely how much good improved road facilities would do; they could easily create

Even if the money could be found for the Victoria Tube, however, there are formidable engineering difficulties. Existing underground structures—the other tubes, the GPO railway, main line railway tunnels, foundations of buildings and the LCC sewers, many of which are larger than the proposed tunnels of 12 ft 6 in diameter—present a fantastic web through which the tunnels would have to be driven. Where new station premises, interchange passages, escalators and lift shafts are needed, the builders would also have to contend with electricity and gas mains, telephone cables and the secondary drainage systems. Nor is that the limit of the difficulties. As Mr. H. D. Morgan, now senior partner of Sir William Halcrow and Partners, said when opening the discussion, the contractors would inevitably run up against an untold number of mains and services, the presence or location of which would not be known in advance and whose purpose might not be obvious when they were reached. Mr. Morgan believes that the number of diversions to be arranged is certain to be so high as to make the proposal unreasonable. Such work must involve great danger for the contractors. With his authority and experience in the construction of underground railways both within London and elsewhere, Mr. Morgan's dislike of the project must greatly temper the enthusiasm of the sponsors of the Victoria Tube.

Is this check-mate in the bureaucratic game which is played with long-suffering Londoners? If the next move is made by the Minister of Transport deciding to build more car parks or widen some London streets, there will be great rejoicing. But the new freedom will not last long if the Government and the London County Council fail in their efforts to push industry and commerce out of London. Any further growth of London must be stubbornly resisted. One of the largest industrial companies in Britain announced this week that they are to run a regular air service for their staff between four of their works in different parts of the country. That is an efficient and sensible way to approach the problem of movement. We live on a small island but there is no necessity to crowd into one small corner like a herd of animals.

Cover Picture.—*Hand scraping the bore of a large bronze ship's propeller before fitting to the shaft. The propeller is of the type used on a modern Atlantic liner.*

★ ★ ★

Plain Words

One of the more prosaic facts of life which every bride learns from her mother is that the way to a man's heart is through his stomach. Feed the brute and he will live in docility and contentment ever after. Our two main political parties seem to be learning a similar lesson. It is now quite apparent that an electorate which enjoys full employment and full pockets becomes apathetic to political wrangling.

Men will protest over a train which has to be taken out of service; they will refuse to leave the train in the hope that their stubbornness will prod London Transport to action. But they are unmoved by the Labour Party's intention, announced in *pianissimo* notes, to re-nationalise the iron and steel industry. There is an important distinction, of course: if the train is late you don't see your favourite television programme, but if the iron and steel industry is re-nationalised ? . . . The well-fed brute cannot see that far !

Mr. Colin Hurry's survey of public opinion on the question of nationalisation has provoked some violent criticism. It has been what an Irishman would call a free fight: anyone can join in, and in no time at all the rights and wrongs of the business are being argued by many who are hardly qualified to pass judgment. I have followed the arguments with relish, but I can't see either side having a monopoly of moral rectitude. One academic contestant who joined the discussion protested that the questions asked of the public are so phrased as to encourage the giving of superficial answers on matters on which the layman cannot possibly be expected to have the requisite information. Surely that is precisely what we have to do as electors during a general election ? We have to make a choice; we know next to nothing about many of the questions which have been raised; compared with the man who makes a study of, say, economics or the effects of nationalisation, most of us are woefully ignorant. But heaven forbid that we should leave the decisions to the experts; even they cannot agree among themselves. No, let me give my superficial answer, and let several million other electors do the same and perhaps the follies and ignorances will be cancelled out.

But if we want to raise the general level of understanding, if we would like to get just a little closer to the erudition of the experts, let us have more public discussion of the Labour plan to re-nationalise the industry. Mr. Hurry's survey, important though it is, is not half as important as the future of our most modern old industry.

CAPRICORN

Weekly Survey

Targets for Tovarishchi

Mr. Khrushchev's remarkable performance before the Twenty-First Special Congress of the Communist Party of the Soviet Union was an achievement not only of stamina but also of generalisations punctuated with attention to detail. His review of the Soviet economy consisted of the usual announcement of targets as percentage increases from unknown base figures, but taken together they give an outline of the way in which the Soviet economic system is moving. He outlined a 7-year plan of development and he also said that the " task of overtaking and surpassing the leading capitalist countries in output *per capita* must be carried out." He did not say, as has been reported in some places, that this could be done within the bounds of the 7-year plan. He said quite categorically that it could not.

The USSR plans to increase gross industrial output by 80 per cent between 1958 and 1965, which is an annual rate of about 11 per cent. This is a high rate of expansion by any standard. The rate of increase of industrial output in this country is difficult to measure, but the national income in recent years has been increasing at the rate of between 5 and 8 per cent. Mr. Khrushchev emphasised in his speech the need to extend existing works rather than build new ones wherever possible (the exact context was the steel industry) and he also had a great deal to say about raising the technical level of the engineering industry. Aluminium output is to increase nearly threefold in the next seven years; copper is to be doubled; iron ore is to go up by 100 per cent; chemical products must increase threefold; petroleum and natural gas are to be developed rather than coal; and electric power consumption is to be increased by 120 per cent. Several nuclear power stations are to be built, a subject significantly dismissed in a six hour speech in 14 words.

The Soviet liking for targets and the translation thereby of the desirable into the possible is seen in the case of consumer goods. Said Mr. Khrushchev: " Consumer goods must be of good quality, handsomely finished and neatly packed, while foodstuffs must be packaged. More than 1,600 food and light industry factories will be built to cope with the assignments . . ." With the standard of living of the Russian public as low as it is at present, planning of consumer goods presents no great difficulties. But once they have tasted the fruits of prosperity, the tovarishchi may begin to show a less comradely, even competitive, spirit, if only to keep up with the Ivanovitches. In the day that the Russian woman achieves the same standard of living and sales fickleness as her American counterpart, she will do terrible things to Mr. Khrushchev's 1,600 factories.

Profit as a Function of Size

Italy is the land of the small firm. At a Conference organised by Confindustria, the Italian FBI, the under-secretary for trade stated that 98 per cent of " productive units " have less than 50 workers. On the same day the research bureau of the Industrial Union of Turin published a survey on the profitability of different sized firms. The investigators divided companies into ten categories according to their share capital. The interesting result emerged that all the smallest companies, those with capital of from one to five million lire, were losing money. The biggest profits were made by the medium sized firms irrespective of what they manufactured.

This effect is ascribed by the researchers to the fact that these firms are of a size where personal supervision, and self-financing are possible. When it comes down to particular industries, mechanical engineering, which is much the biggest employer among Italian industries, shows an increase in profits going along with an increase in size. In other words the largest firms make the greatest profits in relation to capital. But this only happens in engineering. In mining, leather, clothing and paper, profit returns fall as capital grows. Chemicals, electrical machinery, textiles, woodworking, printing, publishing, building, rubber and miscellaneous manufacturing all show the best returns in the middle ranges.

It must be remembered that this survey was carried out in the Turin area so that its findings are not typical of what happens elsewhere. So far as engineering is concerned this region contains some of the biggest firms in the country. These are served by many satellites whose prosperity depends on what happens to the big fellows. To paraphrase an old proverb " What's good for Fiat Motors is good for Italian industry."

Unsettled Market

For those who look for a winter thaw in the Free Trade Area impasse, the two documents issued by the Government proved a disappointment. These two publications were a White Paper, *Report on the Course of Negotiations up to December, 1958* (Cmnd. 648, Stationery Office, 9*d*) and a Blue Book, *Documents Relating to the Negotiations from July, 1956, to December, 1958* (Cmnd. 641, Stationery Office, 10*s* 6*d*). Between them these two give an interesting account of the negotiations about the Free Trade Area from 1956 to the end of 1958. They fill in a lot of detail on ground which was already well known. They are entirely factual and give nothing away so far as Government policy on the future of European trade is concerned.

At the moment the British Government is thinking very much in terms of multilateral free trade, including the freeing of imports from North America. This is inevitably bound up with the admission of consumer goods from the dollar area and the continuing satisfactory performance of sterling. If dollar consumer goods come in without control, a further step will have been made in freeing the pound, and this is a matter which inevitably takes priority over such matters as the Free Trade Area.

Suggestions by the Dutch that the United Kingdom should come into the European Common Market have aroused little official enthusiasm in London and indeed the Paymaster-General has said that such a step is impossible. Meanwhile the members of the European Common Market are being obliged to have another look at the Free Trade Area owing to the difficult position which now faces Austria. Some re-thinking about the FTA with the problems of some of the weaker members of the OEEC outside the European Economic Community may, therefore, soon take place. Such an approach would be entirely different from the one over the years 1956 to 1958 when the dominant fear among the Latin members of the Common Market was the strength of Britain. Now it is to be the weakness of Austria.

Unrestricted Money Raising

The Capital Issues Committee, like Charles I, has been an unconscionable time in dying. It was, however, formally interred last week except for borrowing by local authorities. The Order establishing the CIC has not been rescinded because it is considered desirable to retain the means of control on overseas borrowing, but so far as private industry is concerned the CIC has ceased to function except in the case of redeemable shares or securities for capitalising profits or reserves. This last limitation on redeemable

bonus issues is to prevent tax evasion. Private industry may now borrow or issue shares up to any amount for the normal purposes of increasing its fixed assets or working capital.

It is clearly the hope of the Government that this step will encourage industry to raise capital for expansion. Local authorities are still subject to Treasury control but they have been encouraged for some time to use the facilities of the London capital market and many have done so on favourable terms. There is nothing, therefore, in the new position which adversely affects local authorities. In the same way foreign borrowers are not further impeded. They are excluded from the measure of de-control.

The effect of the Government's move is bound to be mainly psychological. Money which is raised now cannot have much effect on the unemployment situation for many months to come. A general feeling, however, that expansion is in the air and that the Government is anxious to stimulate it further could be critical for the next stage of the trade cycle.

France Seeks Common Voltage

Back in 1946 the Monnet planners fixed targets for French electricity production which were to be met by increasing hydro-electric generation and by reducing the requirement from coal-fired power stations. As a result production has risen at a truly remarkable rate. The 1947 output was 17,859 million kW high tension and 5,138 million kW low tension. This had increased by 1958 to 45,200 million kW high tension and 10,900 million kW low tension.

Electric generation in France is in the hands of the nationalised Electricité de France. The drive for increased hydro-electric output has produced some notable feats of construction. Chief among these are the dams at Génissiat on the Rhône near the Swiss frontier and at Donzère-Mondragon on the same river. The fact that the demand for electricity has fallen because of the world recession will not lead to any change in development plans. In the long term, France, like Britain, faces a fuel shortage. Present coal surpluses are likely to prove only a temporary embarrassment. The possibilities of the Rhine and Rhône for hydro-electric development are still barely touched. Power stations built along the southern rivers such as the Durance have brought industry to the Mediterranean area.

A plan to bring all France within the range 220 to 380 volts is now being put into operation. This is expected to take 20 years to complete. One advantage of the scheme is that it will bring France into line with the other Common Market countries. This will mean greater sales opportunities for German and Italian electrical appliances in France. There is in any case likely to be a steady demand for these from the areas where the voltage is raised, as it is unlikely that appliances working at less than 120 volts can be adapted to higher voltages. But whoever sells the appliances Electricité de France, as the supplier of all current, will benefit.

Community Airline Indicated

The Rome Treaty establishing the European Common Market provides powers for the Council of Ministers to enforce a common policy on the airlines of the member countries. This has been one of the factors leading to meetings to discuss co-operation between the airlines concerned. So far high-level talks have been held in Paris and Brussels, but it has been stressed that discussions are at far too early a stage for reference to " Europe-Air "—the proposed combined airlines—as a concrete fact.

In a broader context, and quite apart from any provisions of the Rome Treaty, increasing co-operation between major airlines makes so much sense that it is almost bound to come about. Decreasing profit margins, increasing competition, and the high cost of modern air transports all mean that the pooling of both aircraft and maintenance facilities, and close co-operation on planning services can offer potential economies which are not only desirable but a virtual necessity. The economies resulting from individual maintenance units being able to specialise on a particular type of aircraft could be large; the fact that a large total fleet is available could mean that services would be operated with fewer aircraft in reserve for emergencies. The realisation of these advantages presupposes, however, a wide measure of agreement on the types of aircraft to be employed, and consequently that fewer types would be employed. The agreement already concluded between the Scandinavian Airlines System and Swissair (neither of Common Market countries) is based on these assumptions. Such agreements can arise naturally when two or more airlines have already decided to use the same types of equipment. There may, however, be some strains when the time comes for these machines to be replaced. The difficulties are more pronounced when one or more of the countries concerned have native aircraft industries which naturally look to their national airlines for a market.

Provided these problems can be overcome there is therefore the strong possibility that six European airlines will sometime in the future have a common aircraft purchasing policy—and from the point of view of the aircraft manufacturer, function as a single buyer. If this type of international co-operation extends further, the sale of transport aircraft will become to an even greater extent, a case of " winner takes all."

Jam Tomorrow

The roads and railways are obvious and easy targets for criticism. Everyone seems agreed that both are at present unsatisfactory, that without drastic means they will become increasingly unsatisfactory, and that large expenditure is necessary which can only come from Government resources. There is little doubt that the point has been taken and the need understood.

It was responsibly estimated in 1957 that a total of £3,500 million would be needed over the next 20 years to finance road improvements and new construction to meet the steadily growing traffic needs. Excluding the cost of improving urban and minor rural roads and of constructing major new tunnels and bridges, it was estimated that some £2,165 million would be needed for the construction of 800 miles of new motorways, the improvement of 7,000 miles of other tunk roads, and the modernisation of the class 1 roads. Last month the Minister of Transport announced that new construction schemes to a total value of £280 million may be authorised within the four year period 1958-62. This may be compared with the £42 million provided for in the Civil Estimates for 1958-59.

The Federation of British Industries have welcomed the extended programme, but believe that it is still insufficient. In the memorandum to the Minister earlier this month they stated that they would support a considerable increase of Government expenditure in this particular field. They point out that the Minister had himself quoted the annual loss due to delays arising from the present defective road system as £200 million, and that other authorities had given even higher figures. As a form of long-term capital investment, the FBI would support measures to enable expenditure on major road projects to be covered by " below-the-line " borrowing rather than from taxation.

Defective trunk roads mean that traffic cannot move; congested city roads mean that it has a hard job to find a place to stop. Some details of the " Blue Zone " system of limited period parking were given to the House of Commons All Party Roads Group earlier this month by M. Pierre Bourlon who is responsible for its operation in Paris. As with parking meters, this relies on a quick turnover of parked cars, and without some research is it at all obvious that any system of this type means much more than a change of position once an hour?

Letters to the Editor

UNIVERSAL LANGUAGE

SIR, In your article " English the Universal Technical Language?" Urdu has been termed as " the official language of Pakistan . . ." (ENGNG, 6 Feb., '59, p. 169). So far as we know English, at present, is the official language of Pakistan. Once it was said that " Urdu alone shall be the State Language of Pakistan." But, subsequently, it was decided and stated in the late constitution that Urdu and Bengali shall be the State languages of Pakistan.

Yours faithfully,

S. ISLAM.

23 Kersland Street,
Glasgow.
7 February, 1959.

Editor's Note.—On the subject of the above letter, a spokesman in the Office of the High Commissioner for Pakistan, in London, states that until the vocabularies of the State languages are sufficiently developed for use in the modern world of business and technology, English will continue in use as the temporary official language.

CLEAR THINKING NEEDED

Suggestions Schemes

SIR, I have followed the correspondence on suggestions schemes with interest. If the suggestion made by Mr. P. Clavell Blount for a British counterpart of the American National Association of Suggestion Systems were adopted, this would be an excellent solution to the problem.

Failing that solution, would not the British Productivity Council with its many local associations and committees, be a good organisation to co-ordinate the work in this field?

Yours faithfully,

H. E. LARDGE.

321 Manchester Road,
Burnley, Lancs.
6 February, 1959.

SIR, It was not my intention to further the already voluminous correspondence on the recent survey concerning suggestion schemes, but I feel it would be wrong and extremely misleading for anyone to accept the figure of company schemes in this country as being 500.

It is not certain whether, in arriving at this figure, the Industrial Welfare Society have taken into account the work of other specialist bodies in the field of human relations, like the British Institute of Management, the Institute of Personnel Management, and the British Association for Commercial and Industrial Education (BACIE), nor the encouragement given to the smaller companies by Clavell Blount and others. For many years they have distributed examples of suggestion schemes and case studies in setting up such techniques to their company memberships, of whom a high proportion have no contact with the IWS.

It seems, therefore, misleading to suggest that the figure of 500 can even begin to be regarded as a yardstick.

Yours faithfully,

ERIC MOONMAN.

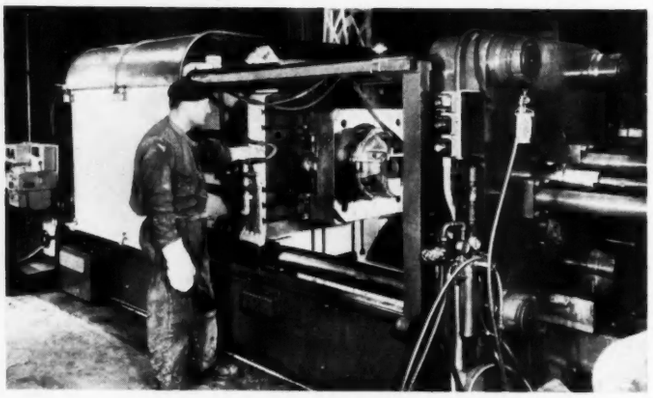
Toynbee Hall,
London, E1.
9 February, 1959.

SIR, The statement in my letter, which you published on page 163 of last week's issue, that Mr. P. Clavell Blount is " the only real authority on suggestion schemes in this country," appears to have caused an impression in certain quarters that Mr. Blount inspired me, in some way or other, to say what I did about him. Since I feel that this is a reflection on myself, as well as on Mr. Blount, I would be grateful if you would put the facts on record.

The only time I have ever met Mr. Blount was after the Industrial Welfare Society's Suggestion Scheme Conference at Brighton last November, when we travelled to London in the

Plant and Equipment

COMPACT DIE CASTING MACHINE



The 60DC20 die-casting machine, for fast semi-automatic casting of light metals, is seen in operation at the Berliet works, Lyons.

Peco Machinery Sales (Westminster) Limited, have recently introduced three new die-casting machines which are designed for fast, semi-automatic casting of light metals and brasses. The largest model—the 60DC20—provides a maximum "cold" shot of 26 lb of aluminium with a maximum locking force of 750 tons and a ram force of 43 tons. Built to a compact design with hydraulic accessories situated conveniently for servicing, the machine will commence a complete cycle after a single impulse from either a hand or foot button. The machine is fitted with power operated safety gates which are interlocked so as to prevent commencement of the cycle if one or both gates are open, and similar interlocking devices prevent the injection of metal unless the dies are completely closed. Although designed primarily for cold chamber operation which may utilise the full locking force, the machine can, of course, also be used for goose-neck hot chamber injection, such as when casting zinc and its alloys.

Up till now five of the 60DC20 models have been produced, three for Fry's of London, with vertical injection, one for Gestetner of North London, which is still on the factory floor, and one for Berliet of France, which is shown in the illustration in operation at their factory at Lyons. Peco's address is 28 Victoria Street, London, SW1.

MEASURING DIESEL SMOKE

An instrument which can accurately measure the density of smoke from diesel engine exhausts or other sources, known as a Smokemeter, has received the approval of the Air Pollution Panel of the Motor Industry Research Association. It is made by Leslie Hartridge Limited, 9 Victoria Street, London, SW1.

The meter, which is 2 ft long by 12 in wide by 12 in high, and weighs 44 lb, consists of a light source and a photo-electric cell mounted at each end of a swinging arm. There are two tubes, one containing clean air supplied under slight pressure by an electric blower, and the other a continuous sample of the exhaust gas, led from the vehicle exhaust manifold or tailpipe. The light source and photo-cell can be moved together so that the path of light to the cell passes either through the tube containing the exhaust sample, or through the tube containing clean air. The output from the photo-cell is connected to a microammeter which is calibrated to indicate percentage smoke density. The air tube is dimensionally identical with the smoke tube and acts as a datum for comparison with the density of the smoke. A mobile power unit is available for use with the instrument.

SUB-MINIATURE RELAY

The series 335 relay made by Magnetic Devices Limited, Exning Road, Newmarket, Suffolk, is a hermetically sealed subminiature unit fitted with two-pole changeover contacts and a balanced armature. It is sealed in a brass can, hot tin dipped. Coil resistance is 5,000 ohms; all standard voltages are available; contacts are rated at 2A; pull-in time 3 milliseconds. Dimensions are 0·78 in by 0·35 in by 1·03 in (including pins) and weight $\frac{1}{3}$ oz.

Continuing

Letters to the Editor

same train together. In a very brief discussion I was much impressed by Mr. Blount's view that the *proper* use of suggestion schemes throughout the country would do much to raise national productivity and improve conditions generally. Since then, in common no doubt with the 50 or 60 others who were at the conference, I have been receiving pamphlets from Mr. Blount on the general subject of suggestion schemes, and the contents of these led to my opinion about him, as stated in my previous letter. I trust you will help me to dispel any mischievous rumour that there has been collusion between Mr. Blount and myself. There has been none.

Yours faithfully,
D. COWPER.

7 Vernon Road,
Birmingham 16.
9 February, 1959.

ORIGIN OF THE PLANETS

A lecture entitled "A New Theory Concerning the Origin of the Planetary System," is to be given by Professor R. O. Kapp, B.Sc. (Eng.), M.I.E.E., at Northampton College of Advanced Technology, St. John Street, London, EC1, on Wednesday, 18 February, at 7 p.m. Tickets may be obtained, free of charge, from the secretary of the College. The lecturer was formerly Professor of Electrical Engineering at University College, London, and Dean of the Faculty of Engineering of the University.

Obituary

DR. J. B. MAVOR

It is with regret that we report the death of Dr. J. B. Mavor. Dr. Mavor, who died on Friday, 30 January, after a long illness, was for many years the design director, and subsequently managing director and then chairman, of Mavor and Coulson Limited, of Glasgow, who were among the first companies to make coal-mining machinery. He had joined the firm in 1910, and in the contracts department installed electric light and power, the side on which his father Henry had founded the business nearly 30 years before.

John Bridie Mavor—his elder brother was the novelist John Bridie—was born on 23 July, 1889. He was educated at Glasgow Academy and then at the Royal Technical College. Thereafter followed two apprenticeships, the first with the Fairfield Shipbuilding and Engineering Company, and then with Drysdale and Company. Before joining Mavor and Coulson he obtained some further experience at the St. Rollox locomotive works of the former Caledonian Railway.

During the First World War he served in the Royal Engineers, finally with the rank of major. From war service he returned to Mavor and Coulson as shop manager; he was appointed a director in 1920 and took charge of design. During this time he supervised the early work on the Samson coalcutter which was largely his own design. New and much improved conveyors also took shape under his guidance.

He became managing director in 1934 and was elected chairman in 1945, from which post he retired in December, 1955. He had also served on the boards of the North British Locomotive Company and of M and C Switchgear Limited of which he was also chairman.

During the Second World War he was chairman of the North West Engineering Employers' Association and of the Emergency Services Organisation for the West of Scotland. After the war he was, for a time, chairman of the Regional Board for Scotland of the Scottish Engineering Employers' Association.

Dr. Mavor also gave of his time to the educational institutions of Glasgow, and served on the boards of both the Academy and the Royal Technical College. His honorary degree of Doctor of Laws (Ll.D.) was bestowed by the University of Glasgow on 20 June, 1956, in recognition of his long service to the city and to Scottish education. During the degree-giving ceremony the Public Orator said of him that he "displayed a remarkable propensity for making himself invisible, but [that] the relentless precision of the man of business, the imaginative faculty of the artist, and the far-sightedness of the Scot, had brought him to many positions of responsibility; he had displayed not only a capacity for distinguished service but had demonstrated over a period of many years the contribution of industry in the sphere of learning." He had been connected with the University for a long time and on two occasions had served the office of Assessor to the Lord Rector.

He was a full member of both the Institutions of Mechanical Engineers and Electrical Engineers; in the session of 1935-6 he was chairman of the Scottish Centre of the latter institution. He is survived by his wife, two sons and a daughter.

Continuing **Plant and Equipment**

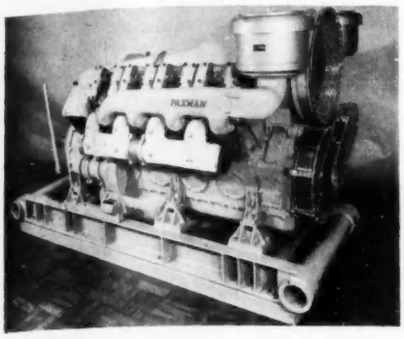


Fig. 1 Vega air cooled diesel engines are rated up to 466 b.h.p. at 2,100 r.p.m.

VEGA and VENTURA

Paxman's New Ranges of Diesels

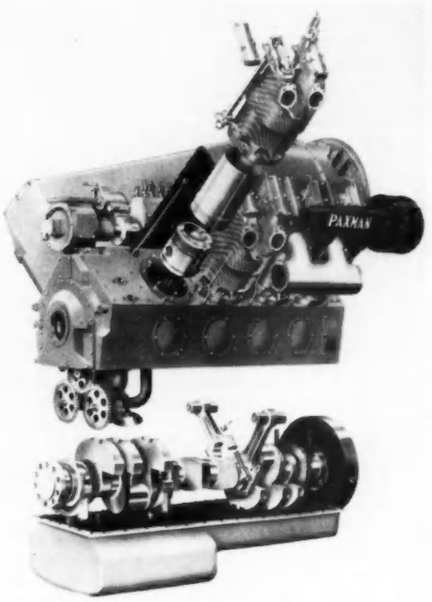


Fig. 2 The cylinder barrel and head of the Vega are a single aluminium casting.

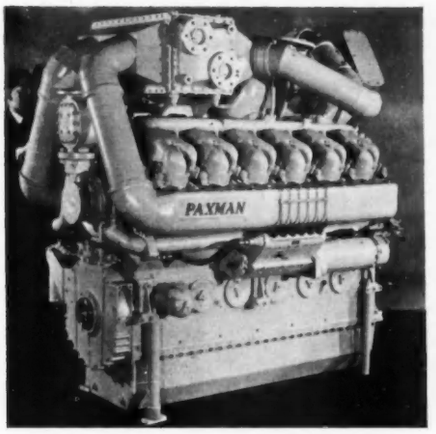


Fig. 4 The Ventura series are water cooled and pressure charged. Fitted with an intercooler, as shown, they have a specific weight of 6 lb per b.h.p.

Two new series of engines have been announced by Davey, Paxman and Company Limited, Colchester, an air cooled model entitled the Vega series and the lightweight water cooled Ventura group. The addition of the first means that between them, Ruston and Hornsby and Paxman can cover air cooled engines from 6 to 450 h.p.; the four Ventura's cover the range 1,100 to 1,870 b.h.p. and are aimed at the industrial and rail traction markets.

There are three models in the Vega range: a six cylinder in-line (the 6YGA) rated at 233 b.h.p. at 2,100 r.p.m., and 8 and 12 cylinder 90° V models rated at 310 b.h.p. and 466 b.h.p., respectively, also at 2,100 r.p.m. (automotive ratings). Maximum torque is at about 1,350 r.p.m. and is 675 lb-ft, 900 lb-ft, and 1,350 lb-ft. Bore and stroke are 6 in and 6·6 in, the compression ratio is 15 to 1 and the specific weight is approximately 10 lb per b.h.p. These engines are therefore suitable for traction and for earth moving equipment as well as for industrial power packs in countries where water is scarce or liable to freeze.

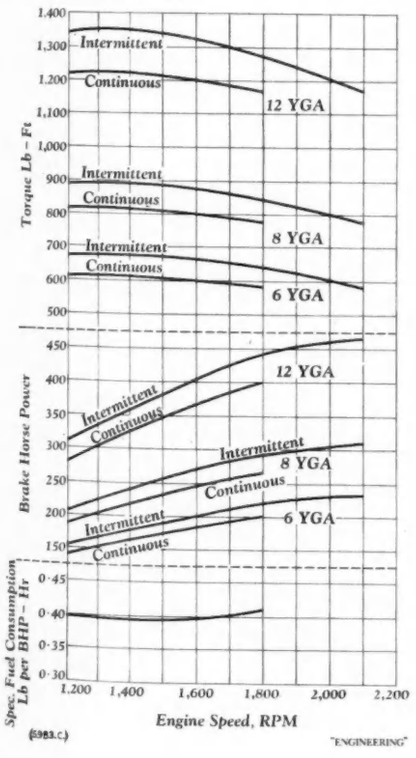
The general design specification of the three engines is similar. The crankcase is a high strength spheroidal graphite-iron casting, carrying a nickel-chrome alloy steel crankshaft with hardened pins and journals. Thin wall copper-lead bearings are used for mains and big-ends. The individual cylinder heads and barrels are one-piece aluminium castings with hardened and tempered cast-iron cylinder liners shrunk in. Single inlet and exhaust valves are mounted at a small inclination to each other, allowing the injector to be fitted in a nearly central position, and at the same time permitting adequate area for cooling air between the ports and the injector. The valves are operated by push rods from a camshaft mounted between the cylinder banks and driven by gearing from the drive end of the crankshaft. The liners can be withdrawn from the barrels for replacement, and the valve seat inserts, also shrunk in, can be reached from the open end for lapping.

The space required for the cooling fins on the barrels allowed side-by-side connecting rods to be used, and the cylinder barrels on each bank are staggered accordingly. An axial-flow cooling fan is driven at twice engine speed from the free end of the crankshaft by a Triplex chain, and the cooling air is ducted to each cylinder bank, there being guide baffles to individual cylinders. In the normal arrangement the air is drawn into the fan and delivered past the cylinders, being expelled from the outside of each cylinder bank. For certain installations it will be possible to reverse the flow, drawing it in from the outside of each bank and expelling it through the fan, from whence it can be ducted appropriately. A temperature-controlled hydraulic coupling can be fitted in the fan hub to permit variable speed operation of the fan if required.

The combustion chamber is of the open type with a near central injector. CAV type NN fuel injection pumps are used with mechanical or hydraulic governing. There are two lubricating oil pumps situated in the sump; one supplies oil at high pressure to the bearings and the other at low pressure for circulation through the oil cooler, which is situated in the air stream at the end of one cylinder bank. To avoid oil leaks, the rocker box has been made in one with the cylinder barrel and the filters are built in, thereby virtually eliminating pipework. The 90° V arrangement assists in cooling and also permits the 8 cylinder engine to be balanced without the use of a second shaft.

The engines can be run at an inclination of 1 in 4 in any direction, and the noise level, inherently slightly higher than in water cooled types, can be greatly reduced by suitable enclosure, such as would be used in skid mounted generator sets. The end bearings are strengthened to take overhung loads. It is believed that at its rating of 466 b.h.p. the 12 cylinder Vega is the largest industrial air cooled diesel engine.

Fig. 3 Performance curves of the Vega range.



HIGH POWER/WEIGHT RATIO

Unlike the Vega, the Ventura has been developed as an addition to an existing Paxman range, the RPH/YHX, with the aim of giving a high power/weight ratio. That this has been achieved can be judged by the fact that the 12 cylinder Ventura occupies the same space as the 12RPH, but has twice the rated power. The Ventura range has 12 and 16 cylinder models, which are pressure charged and can be supplied with or without intercooling. The power range covered is from 1,200 to 1,870 b.h.p. at 1,500 r.p.m. (traction ratings). In each case intercooling raises the b.m.e.p. from 132 lb per sq. in to 154 lb per sq. in, again based on the traction ratings.

The engines are built as 60° V's with the turbocharger and intercooler mounted between the banks. Bore and stroke are $7\frac{3}{4}$ in and $8\frac{1}{2}$ in respectively. The exhaust gas inlet to the turbocharger has four connections arranged in square, and designed to fit directly on the engine exhaust manifold. Pipework has been reduced to a minimum and all water pipes have flanged joints sealed with O-rings.

The main housing, which combines the crankcase and cylinder blocks, is fabricated from steel plate and precision steel castings. The crankshaft is fully counterbalanced with hardened hollow pins and journals. Thin shell copper-lead big end and main bearings are used. The connecting rods are of fork and blade type and

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can be withdrawn through the bore. They are machined and polished all over.

The pistons are in light alloy with Al-Fin cast-iron ring inserts and are oil cooled by a spray from the top of the connecting rod. The liners are of forged steel, chromium-plated internally and externally, and treated in the bore for oil retention.

Cylinder heads are high strength aluminium alloy, carrying four valves with aluminium-bronze screwed-in valve seat inserts. The injector is centrally disposed and each pair of valves is operated by a push rod by means of a single rocker and aluminium bridge piece from a centrally mounted camshaft. Roller tappets are carried in separate castings. All connections to the injectors are outside the valve gear cover to eliminate all possibility of fuel oil dilution.

The drive to the camshaft, fuel pump, governor, oil and water pumps, is by gear train from the drive end of the crankshaft. Two lubricating oil pumps are fitted, one for the pressure system to the bearings and the other for circulating oil from the sump through the external cooler. A single water pump is used and a thermostatic by-pass valve is fitted as an integral part of the water system. The oil cooler can be included in the circuit.

Monobloc CAV fuel injection pumps are provided for each cylinder bank and are driven by cardan shafts from the main gear train at the drive end of the engine, overspeed trips being incorporated as standard. An Ardleigh 300 governor is fitted, the particular type varying according to the requirements of the application.

HIGH-SPEED HYDRAULIC PRESS

A 7½ ton hydraulic press with a much improved range of press speeds has been developed by the Norton Tool Company Limited, Plough Road, Smallfield, Surrey.

The maximum rate of pressing that may be obtained is inversely proportional to the distance through which the ram moves (stroke length). At a stroke of ⅜ in the top speed is 600 presses per minute; at smaller settings the speed may well exceed 1,000 presses per minute. These maximum speeds are said to be considerably higher than can be obtained with the more general types of press, including crank presses, and can no doubt be used to increase the mass production rates of flat and shallow-draw stampings.

Provision for operations such as deep drawing, which require the use of bulky tools, has been made by providing 14 in daylight, 8½ in throat, and a maximum stroke of 6 in. The ram (3½ in diameter) is accurately guided, and it is claimed that its non-rotating action enables precision work to be carried out without the need for expensive die sets. The ram is power-returned to prevent sticking during heavy pressing or drawing operations.

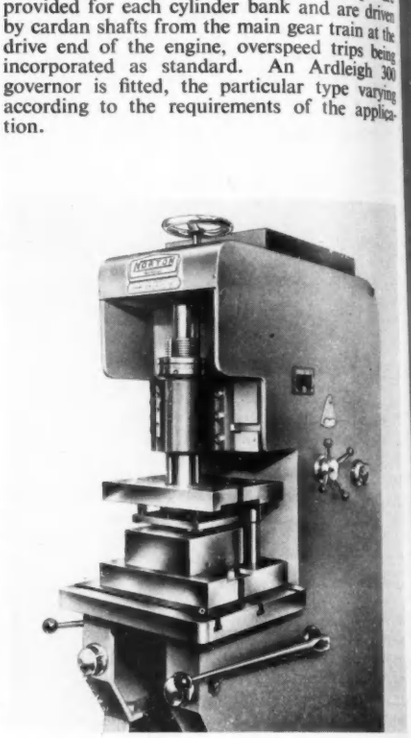
The characteristic movement of the ram is both selected and adjusted by a single control wheel. The range through which this control operates the machine is:—

(i) semi-automatic;
(ii) automatic;
(iii) automatic with adjustable delay at the top of each stroke;
(iv) automatic with adjustable vibratory action at the end of the stroke;
(v) hand " feel " control.

This large range and simplicity of control indicate improved versatility for a hydraulic press and should also lead to an appreciable time saving in setting-up and operating the machine.

The press is made on unit construction lines and has a built-in cooling fan instead of the more usual water cooling system. The power for the entire machine is obtained from a 7½ h.p. electric motor.

The working capacity and speed range of this press will no doubt have particular appeal to the mass-producer who requires the precision performance and power of a hydraulic press.



Hydraulic press works at 1,000 strokes per minute.

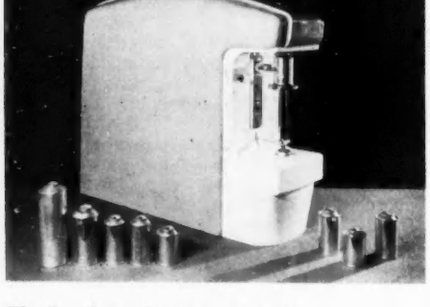
REDUCED COST LAMP FITTINGS

A NEW range of fluorescent lamp fittings, which use one-piece pressings for the reflectors and the gear channels, have been introduced as the " Taskmaster " range of " Flurolier " fittings. The reduced production costs obtained by using the one-piece pressings are to be passed on to the buyer so that the units sell at a relatively low figure. The makers are the Benjamin Electric Limited, Tottenham, London, N17. Fittings are available for 4 ft, 5 ft and 8 ft lamps (single and twin units are made in most but not all of the range) and reflector finishes vary from " Crysteel " vitreous enamel to acrylic plastics, both easily cleaned. Manufacture by pressing has made possible an attractive styling with good lines.

Like the reflectors, the gear channels are also one-piece pressings and are fitted with slide rails for the equipment. Location of the reflector holders has been made easy by using wing headed fasteners, and friction washers, instead of springs, prevent slackening. Miniature glow starter switches are incorporated in the circuits and all plugs and sockets are moulded in white. The bi-pin lampholders, interchangeable for one or two lamps, are also made in white plastics.

To meet the need for improved lamp screening appearance, translucent opal plastics egg-crate louvres are made. They are attached to the reflectors by transverse spring supports which are largely concealed above the louvres but which have claws that catch on the beading of the reflectors. If sold complete with the rest of the fitting, they are not liable to purchase tax.

AEROSOL FILLER



The Presil is a bench top aerosol filler, fully automatic in operation.

A BENCH top machine for charging aerosol cans is now being made by M. Callaway (H.R.) Limited, Saville Works, Croydon Road, Beckenham, Kent.

It enables the three operations of evacuation, charging with product, and charging with propellent to be performed in an automatic cycle through the valve of the fully finished can, eliminating the necessity for refrigeration and crimping plant and also for the wasteful process of purging with propellent. Any one of the three operations may be omitted from the cycle as, for instance, when a very high viscosity product is used, which on the score of time it is quicker to pre-load into the can, and simply to pressurise in the machine.

The operation cycle starts automatically when the can is placed on the platform of the Presil and pressed back against the guide stop. The can is raised under the filling head and evacuated to about 20 in of mercury, the exact figure being adjustable. The dose of the product is then metered in, followed by the charge of propellent gas.

Any fault which develops, such as a hole in the can which prevents the required vacuum being obtained, instantly stops the operation. The can can then only be released by pushing the trip switch. On an average a six ounce can takes 16 seconds to fill.

All the five supplies are connected to the rear of the machine; an electricity line at 230 V 50 cycles, an air pressure supply at 80 to 150 lb per sq. in, vacuum connection, and product and propellent lines, the air being used to operate the sequence valves and to raise the platform. The doses of product and propellent are metered by two separate cylinders, the strokes of which are accurately adjustable. The filling valves in the head can be lifted out for cleaning. Losses in filling are very small as the volume between cut off valve and can is also small.

A very wide range of fluid viscosities can be handled in practice and dispensing is accurate to well within 1 per cent. A range of cylinders is available to cover most can sizes and there is a range of spacers to fit the platform to allow for different height cans. The complete machine occupies a bench space of only 3 ft by 14 in and stands 2 ft 4 in high.

Companies in the News

Americans Buy British

British firms building for United States business will be encouraged by the award of a major turbo-generator contract to C. A. Parsons and Company. As usual the British company's price was well below all American bids. The contract is for a 500 MW set for the Tennessee Valley Authority at a figure of $12·1 million (£4·2 million). The American quotations nearest to Parsons' figure were those of the General Electric Company, who bid $17·56 million, and the Westinghouse Electric Corporation with a bid of $17·63 million.

This order for a very large set is by no means Parsons' first in North America. As we mentioned in a note in these columns "Parsons Tradition Continued" (30 January, p. 135), the first of four 200 MW sets ordered by the Hydro-Electric Power Commission of Ontario is currently being installed. The company's products are working at the same power station and can be inspected. The arguments put forward by the US National Electric Manufacturers' Association against British plant on the grounds of failures, lack of maintenance facilities, and so on, were examined and placed in proper perspective in our leader in the same issue (30 January). The award of the TVA order to Parsons is indeed encouraging, and a tribute to Sir Claude Gibb, who died in the air between the US and Canada.

Point of Departure

News of the proposed Dowty Rotol deal came as a surprise to those who had watched Dowty's progress from the aircraft into the industrial field in the past few years. Details recently released indicate that the £3½ million required for the purchase of Rotol will be raised by means of a new rights issue to Dowty's shareholders, the offer being one new ten shillings share for every two shares held, the price to be decided later. The group's authorised capital is to be increased by £1 million to £4 million. The total offer is of 2·4 million shares, equivalent at par value to £1·2 million of issued capital. A substantial premium is clearly expected if the full amount of the purchase price is to be raised in this way.

Rotol are the largest propeller manufacturers in the United Kingdom and it is beieved that the deal will make Dowty the biggest unit in the aircraft equipment industry. Their large stake in equipment for mining, railways, nucleonics and other industries will ensure that a reasonable spread of interests remains even after this deal.

Mechanical Advantage

Through a series of dramatic and decisive steps, involving the acquisition of two manufacturers of mobile cranes and an agreement with a third for the rationalisation of manufacture, Steel and Company of Sunderland have emerged as the largest builders of mobile cranes in Europe and one of the most powerful in the world. The acquisition of F. Taylor and Sons (Manchester) Limited (makers of the popular Taylor Jumbo hydraulic crane) and of R. H. Neal and Company, Limited, of Ealing and Grantham, provides Steel, already large makers of diesel-electric cranes through their subsidiary, Steels Engineering Products, with the bulk of diesel-hydraulic mobile-crane capacity in the country. Their chairman, Mr. James Steel, stated that the three manufacturing companies "will continue to produce their individual and distinctive models in their own factories and will trade as entirely separate entities competitively in Great Britain. In foreign markets, however, the resources of the three factories will be pooled for maximum advantage in securing the greatest possible share of available world business."

Essentially the move is designed to combat the aggressive bid of Continental crane manufacturers for world markets. In anticipation of the European Common Market, manufacturers in Germany and France have been closing their ranks and rationalising their production which, Mr. Steel points out, "puts them in a favourable position to compete with the larger but less integrated British industry."

The rationalisation agreement was made between Herbert Morris Limited of Loughborough and Steels Engineering Products. It is a reciprocal agreement, whereby Morris mobile, truck-mounted and rail cranes will in future be manufactured at the Sunderland factory, and Coles overhead travelling cranes and electric-hoists at Loughborough. The directors of the two companies are confident that this arrangement will increase the efficiency and economy of manufacture and thus be in the best interests of their customers. The Morris and Coles products will continue to be marketed and serviced separately at home and abroad.

Pole of Accessibility

Gloucester has been selected for the location of "the most modern ice cream factory in the world," mainly on account of its excellent geographical location as a distribution centre for the British Isles. T. Wall and Sons (Ice Cream) Limited, who have just completed plans for erecting the factory, said that its output will go as far afield as Carlisle, Caernarvon and Penzance. Work will begin almost at once and the factory is expected to be in production next year. Another factor contributing to the selection of Gloucester is its good supply of labour.

The 30 acre site will contain a number of ancillary buildings as well as the main factory. There will be a cold store, where the ice cream will be stored for a short while prior to despatch. There will also be a distribution depot for the locality, a wafer factory and two major maintenance workshops. A "repair shop" will be built for the overhaul and maintenance of all the company's refrigerators (for which a central location is important) and a "transport workshop" for the maintenance, body building, painting and overhauls of the fleet of vehicles operated by Walls in that part of the country.

The main factory will be "as fully automatic as is consistent with efficient operation." It will consist of a ground floor for the storage of ingredients, and where the mixing tanks and compressors will be located, and a top floor which will house the production lines, nearly all stainless-steel plant. It will be possible to make ten different types of ice cream simultaneously, at the rate of 45,000 gallons per shift.

Pirate's Progeny

The annual statement of the chairman of Broom and Wade opened appropriately enough with a tribute to the late Harry S. Broom, who was affectionately known as "Pirate." His son Dick, who has retained the name in his more formal chairman's attire—H. S. "Dick" Broom, M.B.E., B.Sc., M.I.Mech.E.—expressed a great deal when he said of Harry Broom "The company was his child, and he loved it."

The child has done well, despite none too bright a year for compressor makers. Trading profits were up slightly to £569,434 and the order book is healthy. The company's greatest success is without doubt their W.R. range of portable rotaries which have swept the board in their field and completely reversed a downward trend in the demand for portable compressors when they appeared two years or so ago. Against all apparent technical justification, two-tool machines have sold exceedingly well and are most popular, with hire firms as well as contractors.

Mr. Dick Broom told shareholders that appreciation was due "to the design, production and research departments for the splendid job they have done in perfecting and making available a range of products which stand second to none in world-wide estimation." Few companies of so modest a size—total assets £3·9 million—could have done as well and the result is a tribute to courageous and imaginative leadership. Competition in world markets is increasing and longer-term credit is in demand. The company's decision to manufacture their products in Australia, the conclusion of arrangements to make some of their products in India, the formation of a company in Belgium—all are evidence of a realistic and interested approach to export trade.

Seventy Years of Welfare

The idea that industrial employers should concern themselves with the welfare of their workers is generally believed to belong to the 20th century and, principally, to the post-war period. It is interesting to recall that one of the most advanced "workers' charters" ever put into operation was evolved 70 years ago when Ernst Abbé, partner of Carl Zeiss in the famous optical concern at Jena, became sole proprietor on the death of Zeiss in 1888.

A brilliant scientist, Abbé was a most liberal-minded man and, in political thought, far ahead of his time. As soon as he assumed control he drew up a remarkable document by which he bequeathed the entire organisation he had built up to a new owner—the Carl Zeiss Foundation.

This document, which earned for him the honorary degree of Doctor of Law, set forth the terms of operation of the Foundation he had created. The "Abbé Statutes," as they are known today, required the Carl Zeiss organisation to undertake only those projects which had a scientific basis. There was to be no investment of private capital in the Foundation, and all the profits were to be divided among the employees, the local university and the town. Clocking in was abolished, holidays-with-pay were instituted, sickness benefits were paid and free legal aid was available to all. Abbé's lifelong concern for the dignity and welfare of the worker can in fact be sensed in every sentence of these remarkable "statutes."

Today the seat of the Carl Zeiss Foundation is in Western Germany, and although Ernst Abbé died in 1905, the spirit he introduced has been cherished and cultivated to this day.

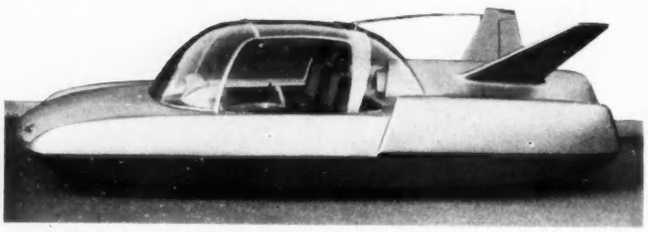
At the Top in GEC and ICI

The board of the General Electric Company have appointed two new directors, Mr. S. G. Catto and Mr. R. N. Millar. Mr. Catto is a managing director of Morgan Grenfell and Company, the merchant bankers, and Mr. R. N. Millar is general manager of the company's heavy engineering and nuclear establishments at Erith. At the same time, GEC announced a large contract obtained from the Central Electricity Generating Board for two 120 MW reheat turbogenerator sets for their power station at Northfleet, Kent. The contract, which includes the condensing and feed-heating plant, is valued at over £2½ million. All six of the 120 MW machines to be installed at Northfleet (the first now being erected, was ordered in 1955) will be of GEC manufacture.

New men have also come to the top at Imperial Chemical Industries. Mr. G. K. Hampshire, chairman of the company's General Chemicals Division, and Dr. J. S. Gourlay, chairman of the Paints Division, have been appointed to the board of ICI. Both have achieved eminence as technical men. Mr. Hampshire is a first class honours graduate in chemistry, joining Brunner Mond in 1923. Dr. Gourlay was a laboratory apprentice with Nobels' Explosives Company, gained a B.Sc. through a part-time course (at the Royal Technical College, Glasgow) and was awarded a Ph.D. from London University for a thesis on the "Viscosity Relationship of Nitrocellulose Solution."

Automobile Engineering

FULGUR DREAM CAR



Detroit engineers are not the only ones to have their flights of fancy and fantasy. The new Simca Fulgur dream car shows that European engineers are looking far ahead too. Alas, it is not yet a working car; merely a full-scale model. According to the project, front wheels are controlled by servo steering up to about 90 m.p.h., when they are retracted and the car rides on its rear wheels only, steered and held at the correct angle to the road by twin servo-operated rudders at the rear. It is driven by electric motors in the rear wheels, operated by batteries in the tail but is also intended at some future date to operate by electrical induction from cables built into the motorways. Steering and braking are intended to be automatic on motorways, radar antennae in the nose look after that and the driver has a TV screen to tell him what is going on; this could be useful in fog. Air conditioning outlets are built into the dorsal fin which carries the rudders. Of more immediate practical significance are the fully adjustable seats with headrests and backrests of variable contour.

Ribbon-type head lamps are supposed to be revealed by a sliding panel in the nose.

BUGATTI THE INVENTOR

Richly endowed with technical imagination and active in a comparatively unexploited field, Ettore Bugatti, the racing-car designer and manufacturer, was also a talented inventor. Though his inventions ranged from multi-spindle machine tools and an indicating micrometer to telescopic bicycle forks, reversible railway seats, Venetian blinds and needle-holders, the greater number of his ideas were of course concerned with motor vehicles; and it was on on this aspect of his work that Mr. H. G. Conway mainly dwelt in his paper presented to the Newcomen Society last Wednesday on " The Automotive Inventions of Ettore Bugatti."

Bugatti designed his first car in 1899-1900; it had a 4-cylinder overhead valve engine, 4-speed gear box and chain drive, and was made in Milan. His first invention, filed in Germany in 1904, related to a yoke-end for steering gear and embodied an elegant and simple means of assembling a split yoke on a taper. There followed an internally expanding rear brake assembly; a 4-cylinder engine with overhead valves, the camshaft being below the crank and operating the valves by means of long tie rods; and a toggle clutch. Shock absorption, cooling of cylinders and valves, steering, rocker systems, bearings, crankshafts, lubrication, braking, expanding bolts and roller chains provided the subjects for some of Bugatti's 1,000 odd inventions, many of which are described and illustrated in Mr. Conway's paper.

The author concludes that many of the inventions, though fascinating, were impracticable if not ridiculous, that few could be judged as fundamentally important, and observes that at one time Bugatti was winning hundreds of races with engines that by aero-engine standards were 20 years out of date. He was stubbornly reluctant to design an engine with pressure-fed hydrodynamically lubricated bearings and retained to the end a valve layout which, though giving plenty of area for the incoming and outgoing gases, did not allow for adequate valve-seat cooling and was thermodynamically inefficient. His achievements lay rather in the quality of his engineering design, which was based on simple and straightforward forms easily machined on centre lathe or horizontal boring machine, and yet readily multiplied into multi-cylinder engines of slab-like appearance. In character, artistry and interest the Bugatti car and engine had few peers.

MEASURING FUEL CONSUMPTION

New fuel consumption test equipment has been installed in a number of factories of Leyland Motors Limited to facilitate research in the design of fuel systems, offering greater accuracy in test-bed work, and reducing the number of personnel required for a particular test.

Developed by Farnell Instruments Limited, Wetherby, Yorks., the electronic equipment incorporates a burette with two level marks and a series of of photoelectric cells. When the fuel reaches the first level of the burette at the start of the test, the first photocell brings into circuit a time interval meter and a revolution counter, thus ensuring that the exact engine revolutions are counted and are not an assumed average. These continue operating until the fuel level reaches the second mark on the burette, when the second photocell automatically brings the test to an end.

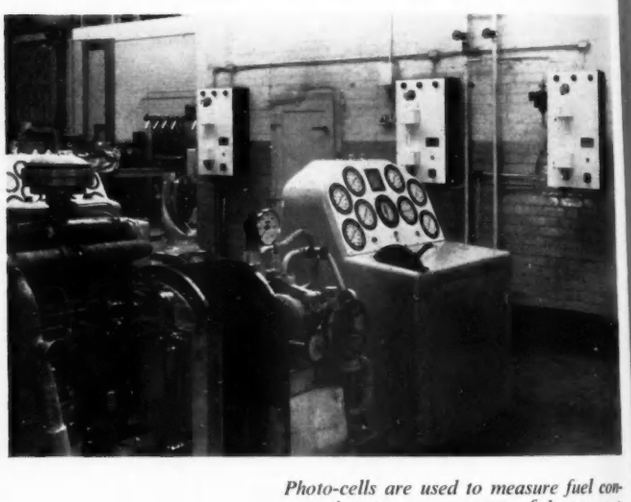


Photo-cells are used to measure fuel consumption to an accuracy of 1 per cent.

To prevent unnecessary stops of the engine when fuel tests are carried out, the fuel consumption tester has been designed to allow the incoming fuel to fill the burette and to feed the engine under test at any time. When the fuel test is required, an electrically-operated valve in the fuel input line closes. Before the fuel has been completely run out of the burette, the photocell operates and opens the incoming fuel supply line thus preventing any break in fuel supply to the engine. Test accuracy is of the order of 1 per cent.

TRANSPORTER

An addition to the range of specialised commercial vehicles made by Douglas Equipment Limited, Kingsditch Lane, Tewkesbury Road, Cheltenham, is the 30 ton transporter shown in the illustration. The vehicle is powered by a 230 h.p. Leyland engine developing a maximum torque of 658 lb-ft; with the auxiliary gearbox, this gives the transporter a maximum tractive effort of 41,200 lb and a top speed of 16·8 m.p.h. The primary gearbox gives a choice of six speeds making in all 12 forward and two reverse speeds. The wheel base is 22 ft approximately, and the overall length 32 ft; the width is 8 ft 1 in. The fuel tank holds 60 gallons. The cab is arranged for normal control and seats three; it is of metal and glass fibre construction. Steering is power assisted. When the auxiliary gearbox is fitted the vehicle can climb gradients of 1 in 2·5.

The Douglas transporter has a tractive effort of 41,200 lb and will climb gradients of 1 in 2·5.

In Parliament

A NEW TUBE RAILWAY

In the House of Commons last week, Members urged the Minister of Transport and Civil Aviation to speed up the plans for the construction of the proposed new extension to the Underground Railway at Victoria, designed to serve passenger needs in North London.

It was pointed out by Mr. E. C. Redhead (Labour) that there was growing concern among the public at traffic problems in London and that powers had been given to the British Transport Commission to construct the Victoria-Walthamstow tube by an Act passed as long ago as 1955. Mr. E. G. M. Fletcher (Labour) referred to the delays which occurred on all London's bus routes and felt that passenger-traffic arrangements in North London were very unsatisfactory.

Mr. Ernest Davies (Labour) pleaded that the matter should be approached from the need-for-increasing-work aspect, in view of the rising figures of unemployment and the unused capacity in the steel industry. He considered that it would be worth while for the Government to pay for the cost of building the tube and then hand it over to the London Transport Executive.

Mr. Harold Watkinson, replying, said that while he recognised that the project would make a valuable contribution to London travel, a number of difficult financial problems were involved. The extension would cost £55 million to build and would lose £3 million a year. He was anxious to take the advice of the London Travel Committee, who had very recently formed a sub-committee to deal with road problems in London, whether the sums involved would not pay a better dividend if they were spent on off-street parking or other projects.

(A Weekly Survey "Go Build a Tube" appeared on 23 January, page 99, and reference may also be made to the leader on page 193.)

DIESEL TRAINS IN SCOTLAND

According to information supplied by Mr. Harold Watkinson, diesel vehicles now provide about 16 per cent of passenger train mileage in Scotland and a further transfer of railway services to diesel traction was intended, but Mr. Hector Hughes (Labour) felt that the progress made was quite inadequate to carry out "what was said to be the policy of the Government," the repopulation of the north of Scotland and the transfer of industry to that area. He considered that essential electrification of railways in Scotland should also take place.

Mr. Watkinson said he understood from the British Transport Commission that, since January, 1955, multiple-unit diesel services had been introduced on six main-line and five suburban routes in Scotland, and that experimental diesel rail-bus services were in operation on two routes there. He could not agree with the comments that had been made because Scotland had had exactly her share of dieselisation since the figure for Britain as a whole was 16 per cent. No doubt schemes for electrification would also be pressed forward. He told Mr. Arthur Woodburn (Labour) that the portable electric-battery trains had brought a lot of passengers back to the railways but that it was too early to say if they would be sufficiently profitable.

TEXTILE MACHINERY NEEDS

A number of matters relating to the existing state of the textile industry in Britain were raised by Members. Mr. Leslie Hale (Labour) asked the President of the Board of Trade whether he was aware that the rapid diminution in this country's exports of textile machinery and of home purchases was causing redundancy and unemployment at a time when re-equipment was necessary.

He suggested that the President should introduce a scheme for the leasing of textile machinery, to be backed by Government finance. Sir David Eccles answered that he was aware of these difficulties. Deliveries of textile machinery were affected by the world situation in the textile industry, which had recently been under-employed in many countries. Proposals for re-equipping the cotton industry were under discussion.

Earlier, Mr. John Rodgers, the Parliamentary Secretary to the Board of Trade, had told Mr. E. Thornton (Labour) that Sir David had had several discussions with Lord Rochdale, the chairman of the Cotton Board, and was keeping in close touch with the preparation of proposals for the re-organisation and re-equipment of the cotton industry. The work was being co-ordinated by a special development committee, representing the main sections and both sides of the industry, which had been set up by the Cotton Board in December.

The committee had prepared a preliminary survey of the probable future size of the industry. In the light of that survey, the different sections were now engaged in examining possible means of action, and would report to the committee as soon as possible. Sir David had emphasised to Lord Rochdale the urgent need for early action and had told him that the Government were anxious to discuss the industry's proposals and to hear if direct Government help was sought.

FUEL AND POWER POLICY

Introducing a Friday morning debate on the Government's fuel and power policy, Mr. William Blyton, Labour Member for Houghton-le-Spring and a member of the National Union of Mineworkers, moved that, having regard to the serious fall in the demand for coal in this country, the high level of coal stocks, and the decline in coal exports, the Government be called upon, as a matter of urgency, to frame a policy for securing a proper balance in the use of imported and indigenous fuel and the effective co-ordination of the nationalised coal, gas and electricity industries.

Referring to the alarm and despondency about the future of Britain's mining industry, he said that it seemed apparent that, in respect of fuel consumption, oil had been given the green signal at the expense of coal and that the coal industry was again to become the whipping boy of the Government's free-for-all economy.

Mr. Gerald Nabarro (Conservative) moved an amendment to the effect that, instead of being called upon to frame a policy, the Government's present policy for the fuel and power industries be endorsed. He felt that to say that the Government had declared war on coal was manifest nonsense. Briefly, the fuel policy of the Conservative Government was to provide sufficient energy—fuel and power—for British industry, commerce and the domestic consumer; to give consumers the freedom to choose the kind of fuel they needed for particular purposes; and to use the country's indigenous sources of fuel and power to the maximum, providing that it was economically sound so to do.

Investment by the Labour Government in the coal industry in 1951, their last year in office, amounted to £32 million. In 1958, the present Government's authorised investment was £104 million. That was the measure of present Government support.

METHANE GAS IMPORTS

It was pointed out by Mr. Emanuel Shinwell (Labour) that to use coal in a raw state was as old-fashioned and outmoded as the use of the antimacassar and artificial fruit. There should be greater facilities for gasification and carbonisation. The need was for a balanced policy and the Government should say what it ought to be.

Sir Albert Braithwaite (Conservative) expressed doubt whether the National Coal Board were marketing their commodity in the best way. He thought that Britain's lost export markets could be regained if the right action were taken. A Select Committee should examine the country's fuel and power policy. The previous inquiry was in 1947—a long time ago.

Another menace was coming along. A 30,000 ton vessel was on the way from America carrying compressed gas amounting to the equivalent of 12,000 tons of coal and following a recent visit to the United States, he understood that 30 other ships were to be built to further the sale of compressed gas all over the world. If that gas were to be allowed to come here and destroy this country's carbonising industry, it might well be that there would be 40,000 miners, and not 14,000, out of work. One could not train miners; mining was bred into men. Working in mines was a family tradition. Once destroyed mining ability took generations to restore.

Sir Keith Joseph (Conservative) stressed that miners used nylon and cotton workers used oil, and that both wanted to stop their own obsolescence; yet each enjoyed the fruits of processes that displaced the other. It seemed that processes of change could not be checked and that the producers of products made obsolete by newer, more acceptable and more convenient materials could not be protected without causing a disproportionate injury to consumers generally.

DEMAND THE DECIDING FACTOR

In his reply, Sir Ian Horobin, the Parliamentary Secretary to the Ministry of Power, said that the Government had not closed their minds to the problem of competition between coal and oil, but it was the duty of the National Coal Board to put forward detailed proposals and they would be carefully considered.

The real complaint was not that the nation did not have a fuel policy but that it was getting a fuel policy which the critics for perfectly good reasons did not like. Harassed domestic consumers who decided that it was cheaper to use a convector heater were deciding the fuel policy. So were the owners of offices who considered that they could satisfy their tenants better by one form of central heating than another. So was industry, which found that one ton of oil was equal to 1·6 tons of coal. In the steel industry, one ton of oil was equal to three tons of coal. It was the Government's view that a national fuel policy could not be decided by any Government department. The consumer should have a choice.

The appeal was that oil should be hindered and coal encouraged. He was bound to point out, in this connection, that oil was a great industry developed by British initiative and enterprise. Carried to a logical conclusion, such suggestions could strike at the basis of the whole industrial structure of modern Europe. The Government was sure that the Coal Board's policy, to modernise their industry and make it more productive and competitive, was the right one.

Mr. Nabarro's amendment was agreed to and the motion as amended was also approved.

Road Building Techniques

Asked by Mr. G. R. Strauss (Labour) to say what steps were taken by the Ministry of Transport and Civil Aviation to ensure that the latest techniques for building major highways in the United States were made available to those responsible for constructing motorways in Britain, Mr. Harold Watkinson replied that the newest methods of design and construction used in the United States and elsewhere were closely studied. Technical literature from these countries was available and members of the engineering staff of the Ministry had made a number of visits abroad to gain knowledge at first hand. Similar information was also available to the engineers of the local road authorities.

Standard for Non-Inflammability

Answering a point raised by Mrs. Patricia McLaughlin (Ulster Unionist), regarding the issuing of new British Standards, Sir David Eccles, the President of the Board of Trade, said that the British Standards Institution had now prepared their standard for a high degree of flame-resistance, but that the Institution were still working on one for non-inflammability.

Fourteenth in a Series of Consolidated Reports

ISOTOPE SEPARATION

By
F. I. HURLEY, B.A., B.SC., F.INST.P.,
Head of Laboratories,
Capenhurst Works,
Industrial Group, UKAEA

THE Geneva Conference followed close on the highly successful International Symposium on Isotope Separation held at Amsterdam in the spring of 1957,[1] and therefore few major advances were expected to be reported at Geneva. There is no doubt that publication at Amsterdam affected the volume of material presented at Geneva: for example, there was only one paper on isotope separation from the United Kingdom. Nevertheless, some 40 papers were presented and these were considered in two sessions. The first session was devoted to the separation of the uranium isotopes, the second to the separation of other isotopes of interest in atomic energy, with emphasis on the production of heavy water.

Uranium Isotopes

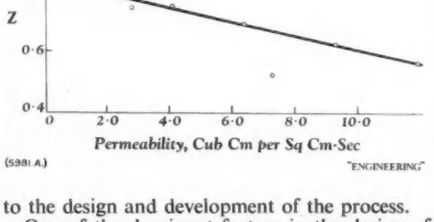
Diffusion Plants

The French decision to describe their work for diffusion plants promised material of considerable interest. However, in assessing this work there is a major difficulty: no comparable release of information has been made by other countries who have developed diffusion plants, and, in consequence, there is no standard of comparison. It might be expected that the techniques which have been developed may find more general application in other plants and problems, but the papers suggested nothing new—for instance, the developments in vacuum technology and their applications to other projects have already been described.[2] In fact, the emphasis in the French papers is on the application of standard techniques to the particular problems raised by designing and building a diffusion plant. These papers must therefore be considered as descriptive of an isolated field of technology which cannot be compared directly with similar work. It is probable that other fields will benefit from the developments of conventional techniques and equipment to adapt them to the rigorous requirements of diffusion plants, but it is not clear from the presentation where these benefits will be manifest; nevertheless, there is much matter of great scientific and technological interest.

In every social group there are unwritten laws which forbid the discussion of certain subjects. In the international social group composed of workers in atomic energy, the technical detail of diffusion plants is one of these forbidden subjects. By presenting these papers France was breaking a social convention, and the point of interest of the session was the way this presentation would be received by other nations. In introducing the first paper, Frejacques made it clear that his country had raised the subject in the hope that this description of the scientific investigations which had been carried out in France would persuade other countries who had experience in this field to criticise and discuss these scientific matters. This appeal for scientific collaboration was unsuccessful.

Economic Aspects.—The first impression received from reading the description of the diffusion plant developments is one of the immensity of the task that was undertaken. This is followed closely by an appreciation of the difficulty of many of the problems that had to be tackled and of the wide range of technologies which had to be called upon to solve these difficulties. Again, although the plant differs completely from any other plant, the papers disclose the universal application of conventional chemical engineering techniques

Fig. 1 Separation efficiency as a function of permeability for etched aluminium oxide membranes.



to the design and development of the process.

One of the dominant factors in the design of a diffusion plant is its high capital cost, which necessitates a most careful and detailed study of the flowsheeting and design of the plant. The way in which the flowsheet is influenced by the cost of electrical power and of the uranium used in the feed is described by Bilous.[3] He points out that while these factors are of immense importance, of even greater importance are the properties of the separating membrane which is available for incorporation in the plant.

Membranes.—The parameters of the membrane which influence the performance are the radius of the pores and the permeability of the membrane, that is to say, the number of pores per unit area. The requirements of a successful membrane are that the radius of the pores should be small and the permeability should be large. It is desirable that the pore radius should be in the region of 100 Å, that is to say, several hundred times smaller than the wavelength of visible light. The dimensions of pores of this size must be estimated by indirect measurements, and indeed the assessment of the performance of membrane materials is a fascinating subject. Various indirect flow measurements may be used to typify the pore size and these must be related to the separation of gases, and ultimately to the separation of the uranium isotopes.[4] In addition to the use of various flow techniques, X-rays, electron-microscopy and adsorption techniques have been applied to elucidate the structure and performance of different types of membrane.[5]

This variety of techniques is justified on two counts. In the first place, the techniques of manufacture generally preclude the possibility of making a membrane with holes of simple geometry to which the ordinary laws of kinetic theory can be applied directly; and secondly, the separation of the uranium isotopes is so small with a single pass through the membrane that indirect methods of assessing the separating efficiency must in general be used, and direct measurements of uranium separation only used as a final check. It is not surprising that the intensive study of membranes has thrown up some difficulties in the fundamental physics of flow through fine holes. A series of elegant experiments is described in a paper by Berman (USA) who shows that the flow through simple pores deviates from the recognised laws of kinetic flow. When most of the gas molecules collide with the wall in passing through the pore, the flow depends both on temperature and on the nature of the gas; Berman suggests that the effect is associated with details of the gas-wall collision process.[6]

Two general methods have been described for manufacturing membranes.[7] In the first a uniform sheet has holes made in it, for example, by etching one component or by anodic oxidation; in the second method a permeable sheet is formed by sintering or bonding discrete particles together. In the Scientific Exhibition at Geneva examples of membranes made by sintering alumina and by compressing Teflon were demonstrated by the French. An ingenious method of fabricating a composite membrane is described by Mårtenssen of Sweden.[8] Aluminium powder is deposited on a fine mesh wire

GENEVA DISTILLATE

Prolific in papers and enormous in scope, the Second International Conference on the Peaceful Uses of Atomic Energy can only assume its true significance when the information presented there has been thoroughly digested. As a stage in this process, ENGINEERING has commissioned sixteen specialists to summarise the matter of the Conference under a number of subject headings. The process may be regarded as one of distillation, with concentrated fractions drawn off at various levels. The contributors have consolidated the information published during the Conference, selecting the essentials, reconciling the submissions of different authors and countries, and tabulating the most important data. As an introduction to the series, we published on 19 September Sir John Cockcroft's overall survey of the Conference. The present series is being published at weekly intervals and will include sixteen articles in accordance with the table. The Conference was held in Geneva from 1 to 13 September.

Power Reactors (28 Nov., page 694) ..	Mr. G. W. K. Ford, Research Manager, Dounreay
Research Reactors (21 Nov., page 662)	Dr. V. S. Crocker, Reactor Division, Harwell
Thermonuclear Research:	
(Pinch Effect) (19 Dec., page 796)	Dr. A. A. Ware, AEI Research Laboratory
(Other Devices) (26 Dec., page 824)	Dr. R. J. Bickerton, Controlled Thermonuclear Research Division, Harwell
Propulsion .. (7 Nov., page 600)	Mr. B. T. Price, Reactor Division, Harwell
Radiation Shielding (31 Oct., page 568)	Mr. J. D. Jones, Reactor Division, Harwell
Reactor Engineering (5 Dec., page 730)	Mr. R. P. Kinsey, Chief Engineer, Advanced Reactor Design Office, Risley
Metallurgy and Fuels (23 Jan., page 106 and 30 Jan., page 136)	Mr. L. M. Wyatt, Technical Manager, Risley
Instrumentation (12 Dec., page 762)	Mr. R. B. Stephens, Mullard Equipment Ltd.
Nuclear Physics (24 Oct., page 536)	Dr. M. J. Poole, Nuclear Physics Division, Harwell Dr. M. Sowerby, Nuclear Physics Division, Harwell
Radioactive Isotopes (14 Nov., page 634)	Mr. E. R. Wiblin, Isotope Division, Harwell
Isotope Separation	Mr. F. I. Hurley, Head of Laboratories, Capenhurst
Chemical Processing (6 Feb., page 172)	Dr. R. Hurst, Director, Dounreay
Radiation Protection	Dr. L. S. Eve, Radiobiological Adviser, Health and Safety Branch
Reactor Safety	Mr. F. R. Farmer, Head of Reactor Safety Division, H & S Branch

On the 1958 Geneva Atomic Energy Conference

gauze of nickel by sputtering. After deposition the powder is forced into the mesh by rolling and then the whole sheet is sintered. It is claimed that this method allows production of a very thin porous layer, combined with adequate strength for handling. The radius of the pores of all the membranes described is in the region of 200 Å. A typical curve showing the relationship between permeability and separating efficiency of a membrane is given in Fig. 1.

High Vacuum Requirements.—The necessity to apply high vacuum techniques to all components of the plant is emphasised in several papers. The necessity of high-vacuum construction to prevent the inleakage of contaminants to the process, which operates at sub-atmospheric pressures, is generally appreciated. High-vacuum techniques are also applied to clean the plant by removing volatile impurities which might react with the uranium hexafluoride; this technique is of vital importance to the success of the plant.[9]

French Experimental Cascades.—Two experimental cascades have been built, each consisting of 12 stages. For the first, laboratory equipment was built to measure the separation of the uranium isotopes produced and to gain experience in the operation of a separating cascade of stages.[10] The second was in the nature of a pilot plant, being built of components which might be used in a production cascade. Its primary purpose was to gain experience of the engineering problems of construction and operation of a diffusion plant[11] (see Fig. 2).

Other Methods of Separation

The development of other methods of separating the uranium isotopes is not so far advanced in Europe as the diffusion plant method. Papers were presented describing the development of the nozzle method and the ultra-centrifuge method.

The Nozzle Method.—The most recent developments of the nozzle method were described by Becker[12]. The gas is forced through a nozzle in the form of a fine slit at low pressure; the light isotope tends to concentrate in the periphery of the emerging jet, the heavy isotope at the core of the jet. The advantage that is claimed for the method is that it eliminates the necessity to manufacture a membrane with many fine holes. However, the slits have to be of the order of 0·05 to 0·1 mm wide. A serious disadvantage of the process is that it operates at low pressures —only a few millimetres of mercury; thus relatively large and costly pumps are needed. The paper describes measurements of the separation of the uranium isotopes and points out that although the method does not yet compare favourably with the diffusion method, the development is in a very early stage and should be capable of considerable improvement.

Centrifuges.—The main interest in the centrifuge method was aroused by a paper presented by Kistemaker,[13] who makes an economic comparison of diffusion plants and centrifuges applied to the production of enriched uranium for a power reactor programme in Western Europe. The argument is based on the developments of ultra-centrifuges by Groth[14] at Bonn and by Kistemaker at Amsterdam. It is emphasised that to be competitive an ultra-centrifuge plant must have a low capital cost and a low energy consumption. It is shown that short centrifuges operating at speeds below the shaft critical are unlikely to be economic; if the cost of the product is to compare with USAEC prices for enriched uranium, the capital cost allowable for the centrifuges is too small. If the centrifuge is made longer the separation potential is increased; however, this involves operating at speeds above the shaft critical. With this arrangement the capital which can be allocated per centrifuge is $750 to produce enriched uranium at the American price. While the feasibility of centrifuges for separating the uranium isotopes has been demonstrated with machines operating below the shaft critical, the operation of machines at speeds above the shaft critical is still in the research state. Nevertheless, Kistemaker concluded that centrifuges were the most economical method of separating the isotopes of uranium in the special economic conditions of Western Europe.

The discussion on the session tended to centre on questions of economics and was perhaps the more lively for that. But even after Sinev of Russia had urged Kistemaker to produce specific scientific information for the guidance of those small nations who had to choose between diffusion plants and centrifuges, the only conclusion that could be drawn was that the development of the different processes had not proceeded sufficiently far for a firm assessment to be made.

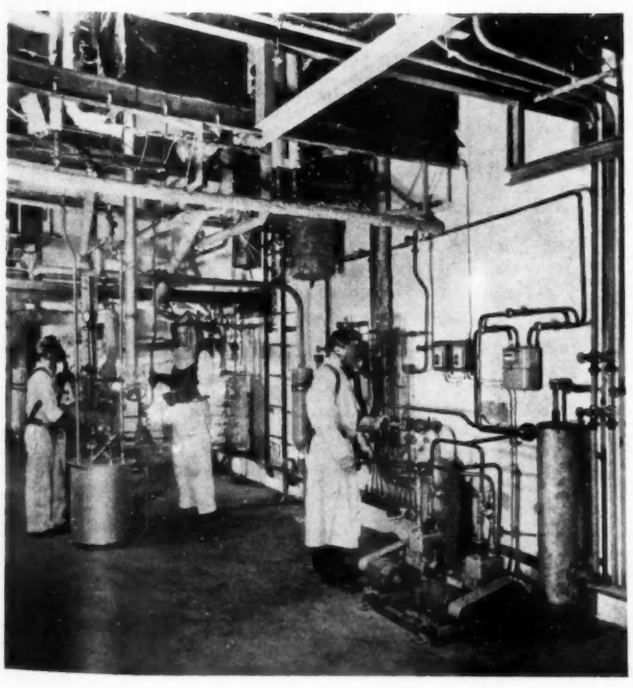


Fig. 2 Gas feed and take-off in the large French experimental diffusion cascade.

Isotopes of the Light Elements

Aside from uranium, the interest in separated isotopes centres on the light elements. These isotopes are used in fundamental investigations in physics and nuclear physics, in biological and chemical investigations and for tracers; boron is important in nuclear engineering because of its strong absorption of neutrons. Generally speaking, only small quantities of the separated isotopes are needed and it is only in the case of the separation of hydrogen and deuterium that large-scale plants are considered and economic factors predominate.

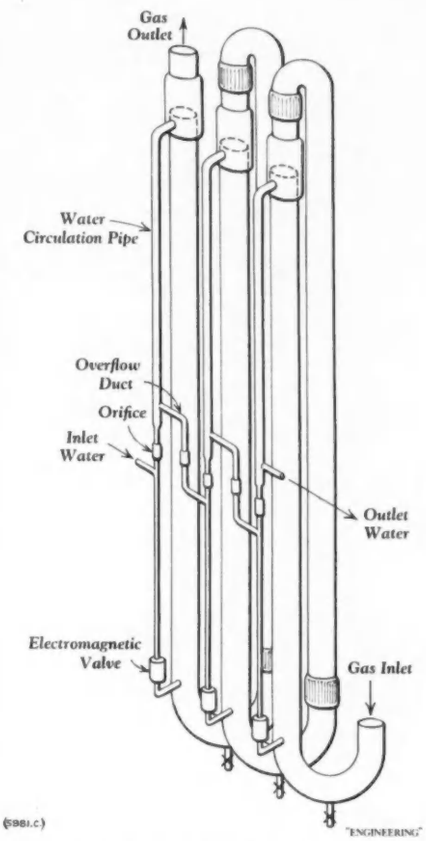


Fig. 3 Interstage connections for gas-liquid diffusion method of separating oxygen isotopes.

When only small quantities of the isotopes are required, economic considerations do not put a limit on the choice of separating methods, and in the laboratory elegant techniques can be used which would be quite unacceptable for large-scale plants. Equally well the requirement for separated isotopes may stimulate the examination of varied separation systems; chemical exchange, diffusion, distillation, electromagnetic methods and so on, have all been studied. The broad range of the Russian work in this field is surveyed in a paper by Zhavoronkov[15]; it is claimed that almost all the isotopes have been separated by electromagnetic methods in Russia.[16]

The difference in the physical properties of separated isotopes is a matter of continuing interest. Clusius[17] describes measurements of the vapour pressures of natural nitrogen, nitrogen composed of equal amounts of nitrogen 14 and nitrogen 15, and pure nitrogen 15; and similar measurements with natural nitric oxide, nitric oxide containing nitrogen 15 and natural oxygen, and nitric oxide containing natural nitrogen and oxygen 18. From his measurements he concludes that the distillation of nitric oxide is the most effective and cheapest method of separating the heavy isotopes, oxygen 17, oxygen 18 and nitrogen 15.

Stream Diffusion

Two papers described the separation of isotopes by diffusion in a gas stream. In both methods a stationary distribution of concentration is established in a moving gas mixture; this distribution of concentration depends on the diffusion coefficients of the individual components. In the Russian equipment the diffusion takes place through a porous barrier; a model was shown in the Scientific Exhibition. The process allows the pores to be larger than the mean free path of the molecules, and holes of

Continuing Isotope Separation

diameter ranging between 0·5 and 5 microns were used. A wide range of isotopes has been separated.[18]

In the Italian system the diffusion takes place from a liquid to a gas, and an apparatus is being built in which the medium is water and this is being used to separate the oxygen 18 isotope[19] (see Fig 3). Both systems have the advantages of high separation coefficients and operation at room temperature, which make them attractive for the production of small quantities of highly enriched isotopes.

Oxygen

Dostrovsky described the plant at the Wiezmann Institute of Science in Israel for the separation of oxygen isotopes.[20] His paper added no new technical details to those he described at Amsterdam,[1] but he did give interesting information on the distribution of the product. The maximum production is 11 grams of oxygen18 a day, which is withdrawn at various concentrations up to 95 per cent. The largest amount is for chemical and biological work at concentrations of less than 30 per cent. The highest concentrations are only used in small quantities, mostly for physics experiments. Dostrovsky estimates that the output of his plant exceeds the present world requirements for oxygen18. The rarer isotope, oxygen17, can also be withdrawn from the plant; at present the maximum concentration is about 5 per cent, but the plant is being modified to produce material at a concentration of over 10 per cent. The interest in oxygen17 centres largely on its nuclear magnetic moment, which permits its detection by nuclear magnetic resonance techniques, and this facilitates studies of chemical structure and bonding.

Boron

The boron10 isotope is of importance in nuclear work because of its high neutron absorption. A plant has been built in the United States to produce 500 kg a year of boron10 at a concentration of 90 to 95 per cent.[21] The separation is effected by the chemical exchange reactions which take place when the complex of boron trifluoride and dimethyl ether is distilled. The product is converted to elemental boron. The plant started operation in June, 1954, and closed down in February, 1958, when it was considered that the stocks were adequate to meet the demands for several years. At a production rate of 50 kg a month, the cost of the separation process worked out at approximately $1 per gram of boron10.

The paper presented by Edmunds on the separation of the boron isotopes describes the commercial application in the United Kingdom of processes that had already been discussed at the Amsterdam Conference.[22] The chemical exchange process is used to produce 95 per cent boron10 at a rate of several grams per day; the complex of boron trifluoride with diethyl ether is used. In presenting the paper the economic aspects were stressed and Edmunds concluded that chemical exchange is the best method for small production rates, but when a larger production is required the low-temperature distillation process developed by the United Kingdom Atomic Energy Authority[1] is more economic. No costs were given to compare with the American quotations, but it is a general experience of isotope separating plants that the costs decrease markedly when the scale of the process is increased.

Heavy Water

The world-wide interest in the production of heavy water was underlined by the ten papers presented to the Conference from eight different countries; the discussion was continued in a separate informal session. The importance of heavy water to the atomic energy industry has stimulated the investigation of many different methods for separating deuterium. In general, a production plant will make use of more than one of these methods.

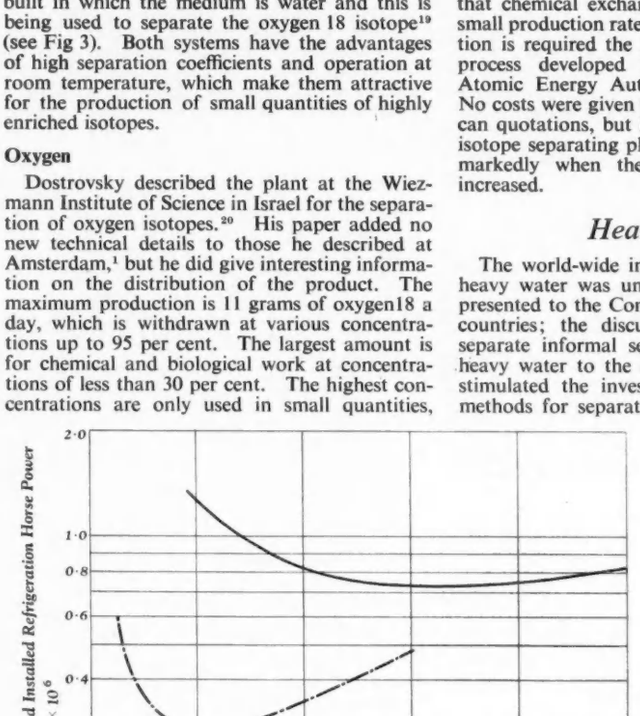


Fig. 4 Capital and operating cost of low-temperature insulation as a function of heat losses for a proposed heavy-water plant.

Production Plants

The reasons for this are explained in a paper describing the United States heavy-water production plant at Savannah River.[23] More than 90 per cent of the effort on separation has been expended when the deuterium concentration has been raised to 1 or 2 per cent. It follows that economic factors dominate only during the initial stage of concentration, and that for greater enrichments the choice of the separating process may be influenced by other considerations. A further consequence of expending most of the effort to enrich to a few per cent is that this material already has a high value and the process chosen for the next stage should be one which is easy to operate and in which the losses are likely to be small. At enrichments of a few per cent the volume being handled is still relatively large, but for the very highest enrichments, over 90 per cent, the volume of material being handled is considerably reduced and the main requirement for the process is that the hold-up of material should be small to keep down the capital investments. In the Savannah River plant the first stage of enrichment to about 15 per cent deuterium is by the two-temperature exchange process between hydrogen sulphide and water. An injunction in the United States courts prevented any description of this process. Vacuum distillation of water is used for the second stage, which brings the concentration to 90 per cent, and finally electrolysis brings the concentration to 99·75 per cent. The production rate is 1 million pounds per year of heavy water; operating costs contribute about $14 per pound to the price of $2[illegible] per pound.

The actual processes which are chosen for a production plant will depend on local conditions such as the form in which the natural hydrogen is available and the nature and cost of the energy source. The local conditions obtaining in India have been examined in detail and it has been concluded that electrolysis, followed by low-temperature hydrogen distillation, is the most economic system; the estimated cost is about the same as material from Savannah River.[24] These processes have been chosen on the assumption that the heavy-water plant would be associated with a fertiliser plant using electrolytic hydrogen and that cheap electricity would be available. Although hydrogen distillation is a relatively untried process the development problems appear soluble and it has considerable economic attractions.

Hydrogen Distillation

There is considerable activity throughout the world in studying low-temperature hydrogen distillation and papers were presented by four different countries. The main problems with this process are to remove impurities from the hydrogen, which at the low operating temperatures appear as solids and block the distillation columns; and to develop a satisfactory low-temperature insulation. The heat-transfer problem has been studied particularly in America where it is estimated that considerable economies can be effected by applying the latest advances in insulation development[25] (see Fig. 4).

In France, together with the development of other processes, a pilot plant to produce two tons a year of heavy water by hydrogen distillation has been built; it was emphasised that this is not a production plant, but had been built to develop the engineering details of the process.[26] The Russian work on low-temperature distillation[27] caused considerable interest and Malkov was subjected to detailed questioning. He did not answer questions on the number of plants that were operating in Russia and details of the costs, but explained that these were commercial questions and that he was a scientist and not an expert in matters of commerce.

New Processes

Two new processes for deuterium separation were mentioned. From Germany, Becker described an exchange process between hydrogen and water which is catalysed in the liquid phase[28]; this should have considerable economic and engineering advantages over current hydrogen-water exchange processes which are catalysed in the vapour phase. In discussion it was suggested that difficulties might be expected with the catalyst; Becker admitted that the life of the catalyst was the weakest part of the process.

In the Industrial Exhibition Costain-John Brown displayed a process based on ammonia exchange and ammonia distillation, for which the costs are estimated to be less than current American prices. In discussion the reliability of the catalyst was again questioned and the establishment of firm costs must await the publication of more operating data.

Conclusions

The papers presented at the Conference, and the lively discussions that ensued, made it clear that there is continuing activity on isotope-separation problems, particularly in Europe. Much information was not disclosed for one reason or another and this has inevitably resulted in considerable re-investigation of problems which have been solved elsewhere. Nevertheless, the study of isotope-separation techniques is in good health and some notable new advances have been made.

It is inevitable that the isotope separation

Atomic Review

Containment and Control

THE peaceful applications of nuclear reactions may now be divided broadly into two areas: the contained and the explosive. In the explosive category the fission and fusion modes may be said to differ only in degree, so that control may be regarded in both cases simply as the channelling and direction of the powerful forces generated during detonation. This use of nuclear explosions, which before the last Geneva conference had only been investigated, as far as is known, under the USAEC's Project Plowshare, has since been considered in a practical context (see Atomic Review 12 September, and 28 March, 1958). The difference between contained fission and fusion reactions, on the other hand, is so marked that whereas in fission reactors containment is provided simply by concrete shielding and, except for mobile applications, represents a relatively minor difficulty, in fusion reactors it is likely to prove the key problem and will almost certainly be effected by electromagnetic fields. But the common requirement of all four processes—explosive fission and fusion and contained fission and fusion—is control, at least in some degree. The following notes are concerned with British work on contained thermonuclear reactions, and then, after a brief outline of the background, three proposed peaceful applications of nuclear explosions are considered.

Siting British Thermonuclear Research

A research station devoted solely to the study of thermonuclear processes may be established in the neighbourhood of Harwell. This proposal is being considered by the United Kingdom Atomic Energy Authority as an alternative to the earlier intention of siting thermonuclear work, including the construction of a successor to Zeta, at Winfrith Heath. The Authority announcement was in fact confined to the statement that Zeta II might be located in the Harwell area, and it has since been disclosed that Culham Royal Naval Air Station, near Abingdon, Berkshire, may be chosen as the site.

It is understood that personnel now engaged on thermonuclear work at AERE do not favour the proposed move to Winfrith Heath since research on Zeta I and other apparatus already installed at Harwell is likely to continue long after the commissioning of Zeta II. (Aldermaston, where considerable attention has been devoted to controlled thermonuclear research, is also comparatively close to Harwell.) To this separation of forces would be added the inconvenience of working at an establishment divided between thermonuclear research and fission-reactor development—including the important HTGC project. The thermonuclear team would eventually number about 1,000 and might well expand further; and at Winfrith Heath such a large detached group might present serious administrative problems. In addition, it would be much easier to attract scientists to an internationally known establishment such as Harwell than to a young and comparatively unknown site. Finally, the need to have a coastal site for fission reactors, where cooling water is abundant and wastes may be piped directly out to sea, does not apply in the case of thermonuclear research.

Readjustments at Winfrith Heath

It seems possible that the defection of the thermonuclear group from Winfrith Heath may lead to a revision in the establishment's top-level organisation. The appointment of Mr. D. W. Fry (who had been ultimately responsible for the direction of thermonuclear work at Harwell) as director at Winfrith Heath suggested that considerable emphasis would be placed on this side of the station's work.

Modification of Zeta I

It is reported that Zeta I has been in operation for something over a month since the first stage of modification was completed. The second stage, for which extra condensers and associated equipment have already been delivered, should be completed during the summer, when it will be possible to discharge about 10 times as much energy as in the original Zeta assembly.

Runaway Ions in Zeta

How ions in Zeta gain energy continues to be debated. In a letter to *Nature* (p. 101, 10 January) Mr. A. Gibson of AERE, Harwell, examines the likelihood of "runaway" ions occurring in the conditions that apply on the average in Zeta. He concludes that they cannot occur.

Above a critical velocity, an ion's rate of loss of momentum in Coulomb collisions with other particles decreases with relative velocity. Such high-speed ions in a plasma could be continuously accelerated by an electric field and so are called "runaway." Mr. Gibson derives the condition for an ion to run away by modifying astrophysical equations, replacing gravitational interactions by their electrical analogues. He shows that, for a sufficiently high initial velocity, the applied electrical force will exceed the frictional force and the ion will run away. In Zeta, however, the velocity of the ion is only great enough if its energy exceeds 200 keV. The ion energies actually observed are less than 20 keV.

Ion runaway could occur in restricted regions of the discharge where conditions are abnormal. But there is not enough evidence to show whether such regions exist or not, and the mechanism producing the observed high-energy ions remains in doubt.

Plasma Heating Mechanism

A mechanism that may contribute to the rapid increase in energy of some of the ions in Zeta is also discussed by Mr. D. Reagan of the Engineering Laboratory, Oxford University. In a letter to *Nature* (p. 102, 10 January) he recalls that the power required to heat a plasma may be greatly reduced by incorporating an oscillation in magnetic field strength at a frequency very much lower than that of electron collision. This has the advantage of heating the ions quickly without appreciably heating the electrons. Mr. Reagan then shows that under the influence of an axial unidirectional electric field, such as in Zeta, the orbits of electrons in a plasma are distorted in such a way that they feed power to travelling magnetic compression waves in the plasma. Under suitable conditions the oscillations could build up and, if their frequency were appropriate, heat the plasma ions.

Enamelled Torus for Thermonuclear Work

For some time Ferro Enamels Limited, Wombourn, Wolverhampton, have been carrying out experimental work connected with Zeta under continuous contract to Harwell. This has resulted in the manufacture of the first vitreous-enamelled torus. The torus is fabricated in aluminium in segments and has been coated with vitreous enamel on the inside to give electrical insulation against 200,000 amperes. A far higher standard of finish was required than that which would be commercially acceptable. Segments are now being produced that have only one microscopic pin-hole per 200 sq. in, and still higher qualities are required. For this reason the atmosphere in which the work is carried out must be free of dust. It has therefore been necessary to pressurise the development laboratory at Wombourn and to filter the air drawn into it. The finished segment is checked for pin-holes with an arcing probe.

High Explosive

Confined Explosions

An American approach which cannot strictly be classified with the laboratory work described above concerns the peaceful applications of nuclear explosions. Recent investigations have indicated that thermonuclear explosions may be brought sufficiently under control to be of help

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Concluding Isotope Separation

sessions at Geneva should be compared with the 1957 Isotope Conference at Amsterdam. The emphasis at Amsterdam was on the exchange of information between scientists; at Geneva this exchange was made more difficult by the wide range of other subjects which had to be discussed, and was overshadowed by emphasis in the papers and the discussions on the economic and commercial aspects of isotope separation.

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Continuing **Atomic Review**

in earth-moving operations, in mining, and conceivably even in the production of energy. Last year an underground detonation of a fission device in Nevada (Project Plowshare) demonstrated the feasibility of confining the explosion; what is more, the bulk of the radioactive fission products was entrapped in the glass from the molten rock. The energy in this case was primarily dissipated at low temperature in vaporising the relatively large water content of the rock, but in addition a very vast quantity of rock was crushed. This could be useful in mining and for the enhancement of the oil flow in large low-specific-yield formations. In the peaceful use of nuclear explosives the fusion reaction is likely to play a prominent role for two reasons. One is that the fusion fuel is exceedingly cheap. The other reason is that fusion reactions give rise to less radioactive contamination. There is no difficulty of principle in the release of large amounts of fusion energy underground; in the conversion of this energy into high-pressure steam and in the use of this steam for the production of electricity. It is, however, important to find a cheap way of confining the explosion in order that the economical exploitation of explosive fusion energy for the production of electricity may become possible. (Geneva Conference P2410, *Peaceful Uses of Fusion*, Edward Teller USA.)

Harbour by Nuclear Explosion

The United States is reported to be planning to create a harbour and channel in Kotzebue Sound near Cape Thompson, Alaska, probably in the summer of 1960, by means of small thermonuclear explosions.

Oil Release by Nuclear Explosion

Plans for releasing some 10^{12} barrels of oil from shale beds in the western United States by a nuclear explosion have been disclosed by the United States Bureau of Mines.

Explosive Propulsion

It is understood that a proposal by which rockets might be propelled by a series of small nuclear explosions is under investigation at Los Alamos Scientific Laboratory.

Notes and News

Berkeley Half Way

The Berkeley nuclear power station which is being built by the AEI-John Thompson Nuclear Energy Company Limited on the banks of the River Severn in Gloucestershire, is nearly half way to completion. The state of constuction may be gathered from the illustration. Virtually complete are the cooling-water intake works and tunnel, said to be equivalent to six cooling towers. The reactor buildings are in various stages of construction as are the radially placed heat-exchanger housings and the annular blower houses, one of which encircles each reactor. The distances between the two reactors and the turbine house are considerable, but it is pointed out that, since speed is a feature of the contract, the greater the working space, the more economically can the construction work be accomplished.

The Berkeley nuclear power station being built by the AEI—John Thompson Nuclear Energy Company on the River Severn is half way to completion.

Most of the heavy civil engineering work has been completed. John Laing and Son Limited, who are responsible for the civil engineering part of the two reactors and cooling ponds, have already placed 100,000 cubic yards of concrete, 5,500 tons of reinforcement and 1,600 tons of structural steel-work. Balfour Beatty and Company, who are responsible for the construction of the turbine hall, workshops, administration buildings, and the condensing water system, have completed much of the more difficult part of their contract, and their section of the power station will be finished ahead of schedule. John Thompson of Wolverhampton, who are responsible for the construction of the reactor vessels, report that No. 1 vessel has been welded and the control rod and charge-tube bosses are being inserted into the top dome of the vessel. After stress-relieving and pressure testing the annular cooling shell will be welded inside the vessel. The eight heat exchangers (now officially termed " boilers " by the CEGB) for No. 1 reactor have been erected and one of them has been completely cleaned and tubed out. During this process absolute cleanliness and humidity control is essential and the staff have received special training for working in the air-conditioned " assembly factory " 70 ft. above the ground. The checking and cleaning of the heat-exchanger tubes continues by day and night. The final set of body plates for No. 2 reactor are about to be sealed in. Plates in the top dome are being fabricated. The completed 165 ton diagrid has been lifted into the vessel, heat exchanger parts have been delivered and are being welded on site in the boiler assembly shop. It is expected that the first of these exchangers will be erected within a month. The first section of steam piping is being fitted, and de-ionisation vessels have been installed in the turbine hall.

AEI through the turbine generator division and heavy plant division, are supplying the following equipment: (1) the complete turbine house equipment, including four 83 MW turbine generator sets, the 3,000 r.p.m. mixed pressure turbines, which take steam at 310 lb per sq. in, 604° F, and 64 lb per sq. in, 596° F, the direct generators for 11·8 kV 50 c/s employing hydrogen cooling at 30 lb per sq. in; (2) two dumped steam condensers, steam jet air ejectors, water-water heat exchangers, oil coolers, and generator hydrogen cooler units; (3) 16 gas circulators and gas duct bellows units; and (4) control rod actuators and nearly 1,000 auxiliary motors (from 750 h.p. to fractional horse power) totalling about 22,000 h.p., made by BTH.

Relationships

The AEI—John Thompson Nuclear Energy Company, who have tendered for the long-awaited Japanese nuclear power station contract, are associated with the powerful Japanese engineering group Mitsubishi. The Japanese are reported to be seeking a reduction of the lowest of the three tenders by £1 million to the figure of £30 million anticipated by the Japanese authorities. It has been calculated that after subtracting the cost of civil-engineering and other locally contracted work the value of the contract to Britain would be between £17 million and £19 million. The tenders, which were opened on 16 January, were submitted by the three groups of which AEI, GEC and English Electric are respectively members.

Babcock and Wilcox Limited, who are members of the nuclear power consortium which includes English Electric and Taylor Woodrow, have had for some time an arrangement with the fifth consortium, Atomic Power Constructions Limited, to supply certain major components of nuclear power stations.

HERO of Windscale

An experimental reactor to be known as the Hot Experimental Reactor Zero (HERO) is to be built at Windscale in addition to the Advanced Gas-Cooled Reactor (AGR) already under construction there. The AGR, which is to have beryllium canning and will operate at about 600° C, will produce 28 MW (electrical) and provide information on operation and fuel element life; while the new low-energy assembly will be used to investigate reactor stability and the efficiency of various fuel-element arrangements. HERO will cost £1·25 million and should be completed in 1961. It will comprise an adaptable graphite structure 19 ft in diameter and 19 ft high; to raise it to a temperature comparable to that in the AGR, the inlet gas will be heated.

German Power Reactor Prototype

Work on the construction of a 15 MW prototype power reactor is expected to begin at Jülich, west of Cologne, Germany, in the next few months. The reactor will be gas-cooled and is said to be of a new type developed entirely in Germany. The West German Federal Atomics Ministry are shortly expected to award the contract to a company formed jointly by Krupp of Essen and the Swiss firm Brown, Boveri, and the cost (just over £3,300,000) is to be borne half by the Ministry and half by 10 German cities—Aachen, Bremen, Duisberg, Düsseldorf, Hagen, Herford, Krefeld, Münich, Würzburg and Wuppertal. It is understood that the reactor will be in closed circuit with a gas turbine, thus dispensing with a steam circuit. (See Atomic Review 2 Jan.)

Naval Chair of Nuclear Engineering

A new chair of nuclear science and technology has been established at the R.N. College, Greenwich, which is responsible for the advanced scientific and technological education of Naval and Admiralty civilian officers. Mr. J. Edwards, B.Sc., A.M.I.Mech.E., A.C.G.I., recently employed as the senior principal scientific officer in the Naval Section at Harwell, has been appointed to the new chair, on secondment from the Royal Naval Scientific Service. Courses are proposed for design specialists, technical officers and commanding officers, and others.

The Human Element

Strike Out Alone

The *News Chronicle* has announced the opening of the lists for its 1959 competition to win £5,000, to invest in a business of one's own. The final will be decided on BBC television where a panel of judges is to award the prize to the most convincing competitor. There is therefore something in it for everyone—the winner, the judges, the paper which sponsors it and the BBC. There is something in it also presumably for the public who watch.

The idea is an attractive one. It is the answer to the urge everyone has at one time or other, to be one's own boss if only one had the money. There is, of course, a limit to what one can do on £5,000. The competition is limited by the sum involved to those whose ideas can be put into operation with a limited investment in fixed assets and working capital. It puts a premium on gadgetry but it may be none the worse for that. It has the great merit as a competition that it evokes the urge to strike out on one's own and risk the consequences of coming out from underneath the shelter of an established organisation. In these days of built-in benefits which go with jobs, there is much merit in subsidising, for a change, a spirit of enterprise.

Why Buy a Business?

In the United States, the United Hatters', Caps and Millinery Workers' International Union has become a majority shareholder in a Massachusetts hat company. The president of the union has said that "every precaution will be taken and every means of examination and review employed, to make sure our original purpose, the safeguarding of our members' jobs, remains the only purpose of our investment." This remark rather spoils the story.

There is a great deal of interest likely to be aroused by a union running a business in the United States. It might well work. American trade unions are favourably disposed to the use of modern management techniques and if they can get a good manager and leave him alone, with the injunction to use modern methods well, the business might be a big success.

If, however, the cardinal aim of ownership is to preserve everyone's job, there is little hope of success if the industry falls on bad times—as has often happened with this one before. This kind of business needs capital and good management to stay at the forefront of a volatile industry. Perhaps, after all, it is going to get it. If the only way to save the capital resources of the company is to dismiss some employees, what will the new owners do? Will the good of a small minority be sacrificed to the good of the large majority of union members whose money is at risk?

Bulge as Reservoir

Employers are being urged by the British Employers' Confederation to train "more young workers during the 'bulge' years than will be required to meet their immediate foreseeable requirements." In the confederation's view, full advantage should be taken of the fact that in 1961 to 1965 some 35 per cent more children will reach the age of 15 each year than in 1956. A report prepared by the BEC's industrial education and training committee has been sent to all member organisations, urging that steps be taken now to expand industrial training.

The present annual recruitment of apprentices is nearly 100,000 a year. If industry were to take an additional 35,000 apprentices for each of the five bulge years, without making any allowance for wastage during training, it would at the end of that time have added about 175,000 trained men to the total skilled labour force—an addition of about 6 per cent. The report emphasises that the absorption of potential trainees cannot be taken for granted: "it will only be achieved if employers arrange their training budgets for the next few years on the basis of wide and continuing expansion."

The report also discusses the dangers of ignoring the growing need for more trained manpower. It points out that during the past 20 years demand for skilled labour has consistently been in excess of what has been available. Even with unemployment in excess of half a million, there were still many skilled occupations "in which the number of unfilled vacancies exceeded the number of persons available to fill them." The failure to build up a trained labour force adequate to meet economic expansion, argues the BEC, will be "much more damaging than any possible temporary surplus of skilled labour."

Stranger Here Myself

The Central Bureau for Educational Visits and Exchanges has now issued its list for 1959. It is again mainly concerned with helping to organise international meetings of young people abroad. A reading of the list of groups in various countries who wish to arrange exchanges emphasises the breadth of the appeal of organised foreign travel for the young. Schemes range from the exchange of groups consisting of the obviously earnest and solemn to the merely flippant. But whether or not travel brings understanding or a broader mind, to be a stranger in a strange land is to experience a heightened awareness of even the most commonplace and familiar things.

Travel abroad for the young is looming larger as the standard of living in Western Europe rises comfortably above the subsistence level. Furthermore, the adolescent, whether holding down a job or an educational grant, is rather better off than his father was, although this is sometimes less true of the children of professional men. It is noticeable that in Russia, where the standard of living has further to rise than elsewhere in Europe before there is cash left over for going abroad, the urge to see other countries is less pronounced—and this is not just because Russia is big or because official policy does not encourage foreign travel.

Meanwhile the young of all countries in Western Europe are shrugging off the attractions of their own local holiday resorts, to go abroad. The 18th century grand tour for the sons of the wealthy has found a 20th century equivalent for all classes.

Rocketry Rewarded

The first award for "research in any or all of the fundamental sciences relating to space travel or space technology" has been made in the United States to a scientist who lived from 1882 to 1945 and began his rocket researches in 1899. The American Institute of Aeronautical Sciences, who administer the Louis W. Hill Space Transportation Award, have announced that the first award, which carries an honorarium of $5,000 has been made posthumously to Dr. Robert H. Goddard who, "despite opposition and ridicule, in more than 40 years of determined effort, tremendously advanced the science of rocketry."

Dr. Goddard's work was valuable even in the last war although the main beneficiaries were the Germans who incorporated many of his ideas and inventions in the V-2 rocket which so many Londoners have good cause to remember. A story told by his widow, to whom the award was presented, shows that rockets to the moon had their appeal to the public even 30 years ago. In the summer of 1929 a trial rocket came down without a parachute and broke up on impact, "as usual." It had, however, been mistaken for a crashing plane and "a caravan of police cars, ambulances and press cars" set out to look for it, reinforced by a spotter plane. A press statement was forced out of Dr. Goddard who protested that "there was no attempt to reach the moon or anything of such spectacular nature." Nevertheless the news reports featured a rocket to the moon that had exploded in mid-air.

No Time for Management

Giving the First Hugh Macmillan Memorial Lecture to the Institution of Engineers and Shipbuilders in Scotland earlier this month, Viscount Simon took as his subject "The Place of the Technologist in Management." In his opinion, management was an art rather than a science. While he would not decry the value of management courses, he considered that skill in management was acquired by a breadth of experience lower down in the organisation, including wide departmental experience.

On the technical side, a manager must have enough grasp of subjects to appreciate broad issues and to handle experts intelligently. He does not need to know more than the experts he leads. The question therefore arises, says Lord Simon, as to whether the good technologist can be spared to acquire experience in management lower down and he thinks that very often he cannot. This is especially true where engineering is advancing rapidly. On the other hand, a man with scientific training can quickly assimilate management experience once it is put in his way.

Lord Simon then goes on to make a most interesting point. He says that the qualifications and experience of the able technical man make it possible in these days of high outlay on research to go straight on to the board without having fulfilled a management function on the way. The point is certainly accepted well enough for some professions such as accountants and solicitors. Why not then for the scientist and the engineer?

Bugatti the Man

The inventions of the automobile engineer Bugatti were so numerous and occasionally so odd that they have prompted Mr. H. G. Conway to inquire in his recent Newcomen Society paper whether the Italian was a mad inventor or a mechanical genius. Lavishly bestowed with creative ability, Bugatti was no doubt occasionally impractical, but his successes on the race track amply confirm his talent as an engineer. Between 1924 and 1926 his cars won no less than 1,045 victories and it has been suggested that "Bugatti cars have won more road races than any other make, quite possibly more than all other makes added together."

Born in Milan on 15 September, 1881, Ettore Bugatti designed his first car in 1899-1900; it was produced by the Bugatti-Gulinelli Motor Corporation at Milan. In 1902 he was engaged by the De Dietrich Company at Niederbronn to supervise their car designs and moved to Alsace, where he remained intermittently the rest of his life. Bugatti designed cars for De Dietrich, Hermes at Graffenstaden and, in 1907, for Deutz at Cologne. In 1909 he moved to Molsheim and established his Bugatti company.

He came of imaginative stock. His father, Carlo, was an artist, painter, sculptor and furniture designer. His brother Rembrandt became a gifted sculptor, but, although Ettore himself was also sent to an art academy for training, he was allowed at the age of 17 to become an engineer.

It is not surprising that this man, born virtually into the Renaissance tradition of artist-engineers, was a prolific inventor. He was also among the world's greatest racing-car designers, though he had a streak of stubbornness, which made him persist with bad design features long after their faults had become obvious to his customers. Yet his long story of successes cannot be fortuitous. Eccentric he may have been; but ability of an extraordinary kind was also clearly his.

Management

COMPANIES IN THE COMMONWEALTH

With so much talk of the Free Trade Area and Common Market of Western Europe, it would be easy to forget that some notable British engineering firms have established themselves firmly in the Commonwealth. By so doing they are actively helping to create a pattern of working partnerships—among advanced and underdeveloped countries—which will go far to reduce the buffetings of international politics. The United Kingdom has a stake in the Commonwealth and, apart from purely commercial considerations, can contribute to the development of those countries, with the satisfaction of participating in new growths throughout the world. This is the fourth of a number of articles in which the present position and prospects of British engineering firms in the Commonwealth are examined. The previous three, published on 15 August, 1958, 19 December, 1958, and 16 January, 1959, considered Hawker Siddeley; Oldam and Son Limited; and Ruston and Hornsby Limited.

4 — Vickers Limited

Vickers Limited are represented in all Commonwealth countries but this article is concerned only with the manufacturing subsidiaries. At the present time the company has manufacturing subsidiaries in Canada and Australia, and there are plans already in hand for opening up in India. No information is available about the size of Vickers's turnover in its manufacturing interests overseas but it is possible to make a very broad guess. Taking 1956 as a basis of the estimate, it is known that in that year about £400,000 was paid in overseas taxation or some 7 per cent of the amount paid by Vickers in the United Kingdom. Making allowance for the fact that taxation is lower overseas than in this country it seems reasonable to suppose that something in the region of £15 to £20 million of the turnover is produced in Canada and Australia.

In Canada, there are four companies operating within Canadian-Vickers Limited. This firm was founded in 1911 and control passed from Vickers in 1927. In May, 1956, however, they regained control of the firm by taking over a 54 per cent interest although there is still a strong local interest in its capital. Within the group are Geo. T. Davie and Sons Limited, Montreal Dry Docks Limited, and Vickers Krebs Limited, the parent company's holding in the last company being only 51 per cent. Geo. T. Davie at Lauzon in Quebec have considerable facilities for ship repairing, shipbuilding, plate and tank work, and Montreal Dry Docks do general ship repair work. The marine division of Canadian-Vickers is closely connected with the building programme for the Royal Canadian Navy. At the end of 1957, Canadian-Vickers and the Davie company had on order or under construction some 135,000 tons of shipbuilding which was about 45 per cent of the work on hand in the whole Canadian shipbuilding industry. If one makes allowance for the tonnage handled for the Royal Canadian Navy, the group must have more than half the business of the Canadian merchant shipbuilding industry.

The engineering division of Canadian-Vickers is heavily involved in building large hydraulic control gates for Canada, the United States and South America. In the mining industry, this division provides crushers, mills, kilns and pumps, as well as extrusion presses for metals and plastics, paper-making machinery, boiler equipment for the chemical and petroleum industries, pressure tanks and food process equipment. It has also produced machinery for the cement industry and some components for the aircraft industry. It is therefore geared to all sections of Canadian manufacturing industry, being closely connected to the development of hydro-electric power, to the expanding mining and petroleum industries, to paper-making and through food machinery to the consumer goods industries. On the engineering side, therefore, Canadian-Vickers should well be able to expand as a key organisation in the capital goods industries.

There are, of course, a number of branches of engineering in which Vickers Limited in this country are interested but which have not yet been developed by Canadian-Vickers. Such development along the lines followed in the United Kingdom may well be necessary. The future of Canadian shipbuilding is problematical and is largely dependent, directly or indirectly, on Canadian Government action. Apart from orders for naval construction and transport department vessels, new tonnage for the coastal trade is dependent on legislation to protect Canadian shipping interests and indirectly the Canadian shipbuilder. This may well limit the openings for diesel engines as well.

Among the Vickers manufacturing activities in the UK which are not yet developed in Canada, two may be singled out. In 1956, Canada imported $21 million of office machinery (excluding typewriters), of which no less than $17 million came from the United States. This market is therefore worth about $7 million a year which is equal to 25 per cent of the annual deliveries of office equipment (excluding typewriters) in the United Kingdom. In other words, it is potentially a significant market. Vickers were, of course, already in the punched-card industry in the United Kingdom through Powers-Samas Accounting Machines Limited, but this position has changed in the past few weeks with the creation of International Computers and Tabulators, of which Powers-Samas is one of the two founders.

The other Canadian example is printing machinery. A country with probably the largest timber resources in the world is in an excellent position to develop through paper into printing and the Vickers subsidiary in the United Kingdom, George Mann and Company Limited, are well known as printing machinery makers, while Canadian-Vickers already make paper-making machinery. Canadian-Vickers formerly had a stake in the Canadian aircraft industry: whether they would ever consider resuming production in Canada is a matter of conjecture. Vickers are not yet interested in steel production in Canada (as they are in the United Kingdom through their 75 per cent interest in the English Steel Corporation Limited). Another English concern has a control of Dominion Steel and the Germans have begun to develop the Canadian steel-tube industry. It would be a major undertaking and would tie up a large amount of capital for Canadian-Vickers to expand into steel, but some day it might come about if it became vital to have control of supplies of the main raw material for its engineering interests. During 1957 the English Steel Corporation established, jointly with Canadian Steel Foundries (1956) Limited, a subsidiary company, Canadian Steel Wheel Limited, to manufacture wheels for the Canadian market.

There are two reasons why British interests in a subsidiary engineering concern in Canada may be expected to grow over a period of time. First, the interim report (the Gordon Report) of the Royal Commission set up to inquire into Canada's long-term economic prospects estimated at the end of 1956 that Canada's national income would increase in volume by 180 per cent between 1955 and 1980. They also expected that there would be a shift in the emphasis of output away from agriculture to manufacturing industry. In 1955, secondary manufacturing (which includes engineering and metal forming as well as consumer goods) took 21·6 per cent of the national income but is expected to account for 25·3 per cent by 1980.

The manufacturing sector of the economy is expected to increase in volume by 210 per cent on the 1955 basis. This is clearly an opportunity for all sections of manufacturing industry, including engineering, although it will involve substantial quantities of capital. Secondly, there is increased reluctance among Canadians to allow the United States to increase its control of Canadian trade and industry. In consequence, the efforts of the United Kingdom parent companies to increase their stake in Canadian industry are likely to receive every encouragement.

In Australia there is a similar company structure to Canada. The holding company is Vickers Australia Proprietary Limited, controlling four subsidiaries. These are Cockatoo Docks and Engineering Proprietary Limited, Vickers-Armstrongs (Australia) Proprietary Limited, Vickers Hoskins Proprietary Limited, and Vickers Ruwolt Proprietary Limited. The shipbuilding and ship-repairing facilities on Cockatoo Island are of the most modern type despite the fact that it is the oldest dockyard in the Commonwealth. The Australian shipbuilding industry is not one of the larger industries in Australia but is rapidly growing in importance. In 1956, for example, five merchant vessels amounting to about 13,400 gross tons were launched from Australian yards while last year eight merchant ships were under construction throughout Australia. The recent decision to extend the major shipbuilding yard at Whyalla will tend towards producing larger ships and greater output. Cockatoo's name has for long been connected with the Royal Australian Navy and the Australian Daring class destroyer is currently under construction. There is, in fact, a tradition of RAN construction work at Cockatoo over many years.

Vickers Ruwolt, which was acquired in 1948, is broadly based on heavy engineering. Its products include mining and quarrying equipment, paper-making, malting and rubber machinery and hydraulic equipment. There is also an important structural steel division. Vickers Hoskins, which was acquired in 1956, is now being expanded and includes in its range of products rolling mills, large haulage winches and cranes.

As in Canada, the prospects for Vickers's subsidiaries in Australia depend on the rate at which an expanding economy chooses to build up its capital equipment by producing plant and equipment locally which at one time would have been imported. Broadly speaking, Vickers's prospects are dependent upon the expansion of the iron and steel industry, mining and quarrying, conveying and handling, and those consumer goods industries which are likely to expand over a long period due to the rise in the standard of living. In this connection, such industries as

paper-making and printing, motor vehicles, cement, structural engineering and chemicals are also likely directions of expansion. The motor vehicle industry is already well established in Australia, while cement-making machinery is a highly specialised industry in which Cockatoo and Vickers Ruwolt are taking an increasingly active part. For the rest, Vickers are already well established at the points of growth, and since experience in one branch of heavy mechanical engineering is very easily carried over into similar products, Vickers Australia Proprietary Limited are well placed for expansion.

The main obstacles to the development of the group would seem to come from increased competition from outside the Commonwealth. So far as imports are concerned, Australia's inclination towards a relaxation of imperial preference might make German and Japanese competition in certain types of capital equipment more severe in the Australian home market. So far, the picture is fairly re-assuring, as can be seen from the following table.

Indices of Industrial Activity in Australia. Base 1952/53 = 100.

—	Industrial consumption of electricity	Tons of ingot steel produced	Employment on building and construction	Value of imports of capital goods
1953/54 ..	102	103	98	101
1954/55 ..	113	106	103	110
1955/56 ..	128	114	106	119
1956/57 ..	142	139	106	108

It will be noticed that both employment on building construction and the value of imported capital goods lagged very much behind the other two general indices of industrial activity in the table. On the other hand, the index of the value of imported capital equipment jumped to 137 in July, 1957, and was still at 133 in August. This index is clearly affected very much by the import licensing policy of the Federal Government and if a liberal policy in this respect can be pursued over a period of time (that is to say if the Australian balance of payments is satisfactory), there may be increasing competition from engineering concerns in other parts of the world in the Australian market. Between 1953/4 and 1956/7 industrial consumption of electricity went up by 40 points.

By the July-September quarter of 1957/58 there had been an increase of 52 per cent. This was a very fast rate of growth and may be compared with an increase in electric power-consumption in Canada between December, 1953 and September, 1957, of about 25 per cent and about 33 per cent in the United Kingdom. These comparisons illustrate the phenomenal, almost hot-house, rate of growth of demand for industrial power in Australia over this period. It is well known that Australian industrial resources have been strained to maintain such a high rate of expansion. Such a rate of increase cannot be maintained for long without serious effect on the balance of payments. The recent performance of the heavy engineering industry in Australia has thus been against a background of phenomenal expansion which may tail off, and indeed the Department of Trade in its *Survey of Manufacturing Activity in Australia*, issued in October, 1957, said: " Over the past few years, investment in manufacturing has been maintained at high levels, and the record number of projects implemented has resulted in substantial advantages to productive capacity." Altogether, it seems that capital investment in Australia is likely to proceed at a more sober pace in future and that those concerns supplying heavy capital equipment will find increased competition for fewer orders. In the long run, however, Vickers Australia Proprietary is well placed to take advantage of the demand caused by a steady rise in the population and standard of living in the Commonwealth.

In 1955, the first steps were taken by Vickers to establish a manufacturing interest in India as opposed to a private trading company and, in 1957, it was announced that agreement had been reached with Babcock and Wilcox Limited and with the Associated Cement Companies of India to set up a heavy engineering works in West Bengal. This is expected to begin production in 1961 or 1962 and will be concerned with cement-making machinery, boilers, pressure vessels, winders for the coal mining industry and other heavy products. Associated Cement Companies are in a paramount position in the Indian cement industry, controlling about 50 per cent of its capacity. Between 1953 and 1960 they had intended increasing their capacity from 2·8 to 5 million tons of cement a year.

The actual capacity figures planned for the Indian cement industry are closely related to the series of five-year plans and the ones given above may be already out-of-date. Nevertheless, they give some indication of the substantial rate of expansion expected in the Indian cement industry. Most of the big cement-making machinery groups in western Europe (including F. L. Smidth and Company of Denmark, Polysius of Germany, and Vickers-Armstrongs Limited of the United Kingdom) have all done business with the Indian cement industry in the past. A working arrangement with the largest cement group in India may prove to be a very astute move. It gives Vickers an arrangement with an outstanding boiler-manufacturing concern in this country and with a large, well-established Indian concern which owns a large number of cement manufacturing subsidiaires in a country which is desperately short of building material. It is therefore well placed strategically for assessing the trend of the whole of the Indian programme of industrial expansion in the second half of this century and for opening up through engineering construction work into a much wider field of heavy engineering activity.

In what has been said above, it is apparent that Vickers are well placed to play an important part in the development of the Commonwealth. By the very nature of their broad basis in the United Kingdom and the experience they have in overseas markets, they are well equipped to take advantage of a rising demand for heavy industrial equipment. They also have a variety of approaches to the market open to them. They can sell direct, sell through their own locally registered sales companies, manufacture locally or enter into manufacturing agreements with companies already established there.

There remain the two questions of trained staff and finance. The development of heavy engineering industries in countries like Canada, Australia and India depends very much on being able to train the right kind of personnel in the necessary quantities. Vickers's reputation for imaginative training of personnel stands high in this country. If Vickers were to expand the range of their interests (as opposed to increasing the capacity of existing ones) they would probably have to call heavily on their United Kingdom experience and facilities for training. At present, they do not use their United Kingdom training capacity to any extent for their Dominion associates but presumably this could be done as the need arose.

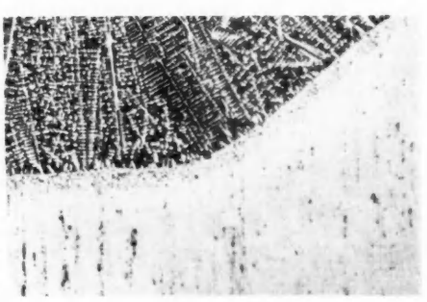
Finance is a constant problem these days for large companies. For those with world-wide ramifications it can mean some difficult decisions as to which line of development shall come first and whether it shall be at home or abroad. One can therefore assume that if Vickers expand still further in the Dominions, local capital will have increased opportunities for participation.

So far as growth overseas is concerned, Vickers are fortunately placed. They are well established with manufacturing subsidiaries in two Dominions, where the standard of living is high and where further increases in the national income mean a rapidly rising consumption of capital equipment per head of population. In India the problems are different but the opportunities are considerable. There is no problem for Vickers to know how to find opportunities abroad. The difficulty is going to be for several decades to know which ones to choose.

Metals and Materials

EASIER HARD-FACING

Deloro Stellite of Solihull, Warwickshire, in conjunction with Radio Heaters of Wokingham, Berkshire, have developed a new method of applying hard-facing alloys which they call the sprinkle-fuse process. Greatest benefit is to be derived from this new method when facing large numbers of small articles such as valve seatings, seat rings and discs, pump sealing rings and thrust plates, when induction heating offers the advantages of automatic heat control, reduction in heating times, and elimination of welding skill. The new process is further claimed to allow more economic use of hard-facing alloy.



Use of high frequency induction heating to obtain fusion of Stellite hard-facing alloys results in good adhesion and little metal penetration or dilution. (*Magnification* × 60.)

From the photograph of the metal structure it is seen that the process retains advantages of the powder spray-fuse process in that metallic penetration and dilution are very small.

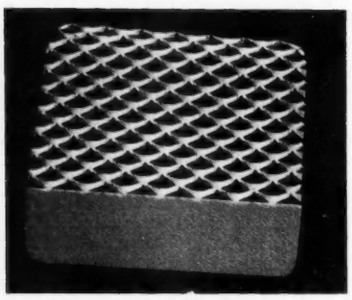
Deloro Stellite alloys are a series of cobalt, chromium, tungsten alloys of which three are widely used for hard-facing. Named 1, 12 and 6 in solid form, or SF1, SF12 and SF6 in powder form, they yield hardnesses of 600, 500 and 400 DPH respectively when applied as hard-facings. Their useful hardness is retained even above 600° C, and their combination of low coefficient of friction and high resistance to corrosion make them suitable for facing shafts and bearing surfaces which have to resist wear. In rod form the alloys may be fused on to the surface by most electric-arc and gas-welding processes in which the electrode or filler rod is made of the desired alloy. The introduction of Stellite in the form of powders made a further method of spray-fusing possible, in which the powdered alloy is cold sprayed on to the surface and subsequently fused by application of a hot gas flame. The use of high frequency heating is a logical development of the latter process, and when the correct heating cycle for a given component has been established, such mass production hard-facing gives sound deposits of controlled depth which are strongly adherent and are free from slag inclusions, blowholes and shrinkage porosity.

Continuing **Metals and Materials**

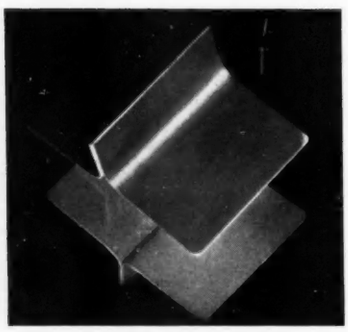
PLASTICS COATED STEEL

Stelvetite is the name of a pvc coated steel which was first introduced nearly 16 months ago by John Summers and Sons Limited, of Shotton, Chester. In a recent exhibition in London were shown the various present applications of the material and some of the equipment which is available for its fabrication. Stelvetite is capable of being worked like ordinary steel sheet and the pvc remains adherent after considerable plastic deformation has occurred, even such as is encountered in deep drawing or " expanding." This is made possible by a combination of an adhesion of 30 lb per in width between steel and plastics, and of good ductility in the pvc coating. The composite material was developed in conjunction with BX Plastics Limited who supply the Velbex or more chemically resistant Cobex-Velbex plastic. Stelvetite can be supplied in any colour when ordered in sufficient quantity, or in any of five colours on small orders. The steel is either bonderised or electrozinc-coated on the reverse side, and is available in thicknesses from 26 to 16 BG (0·0196 to 0·0625 in), while the pvc is always 0·014 in thick.

The Velbex pvc coating has an adhesion strength of 30 lb per in width which allows " expanding " and deep drawing.



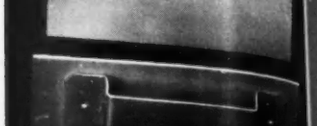
Plastics to plastics welding is most easily performed by high frequency induction heating.



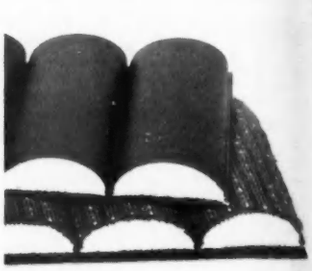
The plastics is at present supplied mainly with a " leathercloth " finish, but the makers have developed a smooth finish which they envisage will be useful for refrigerator liners and perhaps for the exterior panels of cars. Major uses are in pressed steel components especially for equipment cases and cabinets, and for chemical containers. This last application is perhaps a great potential outlet, for one of the main advantages of the Stelvetite is that the pvc is resistant to dilute aqueous solutions of most common acids at room temperature, to alkalis, oils and fats. It may find use for domestic water cisterns and is already being used for chemical drums. Stelvetite lends itself to one application from which ordinary steel sheet is precluded—that of upholstery. With high-frequency heating the pvc on the Stelvetite may be softened and made to bond to either fabric or further pvc sheet, whilst for padding a foamed plastics may be interleaved between the two.

Welding can be undertaken in one of two ways —either plastics to plastics, or metal to metal, but has presented minor difficulties. The pvc may, of course, be stripped from the steel surface to allow fusion welding, but more refined techniques of spot welding and high frequency welding may now be carried out without such resort. High frequency welding of plastics to plastics is straightforward. Where Stelvetite is bonded to Stelvetite, the metal backings are made the electrodes, and so long as uniform pressure is applied and the surfaces are flat, a strong bond is obtained. Radio Heaters make a range of induction equipment which give efficient dielectric heating at a frequency of 50 to 60 M/cs. When sealing exposed seams, such as on welded drums, a straight plastics strip is used and a specially contoured electrode must be provided. Difficulty in spot welding on to the back of Stelvetite arises primarily from the tendency of the plastics to lift from the surface near the fused spot. Several manufacturers have built equipment which overcomes this by providing a fast weld time of one fiftieth to one hundredth of a second with a massive water cooled support on the pvc side of the sheet. Two electrodes are used, either one or both producing spots, the latter being a particularly suitable set-up for welding thin gauge reinforcements on to the back side of the composite sheet.

Riveting and rolling present no difficulties, and seams may be further filled with a pvc rod with the aid of a hot air welding gun.



Metal to metal spot welding has demanded equipment which can provide the necessary heat in one fiftieth to one hundredth of a second.



Stelvetite lends itself to the manufacture of upholstery, where high frequency heating is used to obtain the bond.

ALUMINIUM ROUND THE BEND

The Aluminium Development Association has just published a booklet on Bending Aluminium which is described as an Information Bulletin. It starts off by giving sufficient background to allow a preliminary choice of alloy for a given bending application although there is the sober reminder that " the only reliable means of determining the bending behaviour of a particular alloy form and temper is to try it out under conditions as near as possible to those found in production." After a few further paragraphs on how and why the bending operation is not always an easy undertaking, it goes on to say what can be done on the shop floor on a practical basis.

The bulletin is addressed mainly to production engineers, designers, draughtsmen, works managers and foremen, but ADA have written it to be helpful to the operators as well. It indicates how to bend anything from sheet to fine gauge tube, and should enable those whose aluminium breaks round the bend to analyse their trouble before they go the same way themselves. Copies are obtainable from the Association at 33 Grosvenor Street, W1 (2*s*).

CORK-ELASTOMER GASKET MATERIAL

A new gasket material—Uniphase Cork—has been developed for applications where neither conventional cork composition nor cork and rubber have been completely satisfactory, it is announced by Armstrong Cork Company Limited, Honeypot Lane, Kingsbury, London, NW9. The main feature of Uniphase cork is its continuous phase synthetic elastomeric binder which encloses all the cork particles in a continuous matrix. Oil penetration tests at 212° F at a pressure of 30 lb per sq. in show that because of this continuous phase, oil penetration is only one third that of cork and synthetic rubber gaskets, and one fifth that of a conventional cork.

Uniphase forms a positive seal at unit loads as low as 100 lb per sq. in where many other conventional materials fail, primarily because the elastomeric binder conforms to surface irregularities at low pressures. However, at the other end of the scale, such gaskets will withstand loads of 4,000 lb per sq. in without being crushed or extruded. The composite material is claimed to have very good resistance to fungus growth and to have chemical reistance approaching that of natural cork.

ACRYLIC MOULDING MATERIAL

Diakon is a form of polymethyl methacrylate thermoplastic material which is available either in fine powder or in regular cut form. The makers—ICI Limited (Plastics Division), of Welwyn Garden City, Herts., are now offering uncoloured powder polymer which will enable consumers such as injection moulders and extruders to prepare their own coloured polymer by a simple tumble-blending process.

In addition to their excellent dimensional stability and low water absorption Diakon mouldings are noteworthy for maintaining their appearance over long periods even when exposed out of doors. The colouring pigments and dyes used during manufacture are stable and mouldings which have been in use for ten years have shown no detectable colour variation.

Present applications of the material are mainly in the motor car industry for components like rear reflectors, lamp covers and housings, instrument dials, and horn buttons, but the GPO has chosen it for the new pattern coloured telephone instruments and it is also widely used for injection moulded fittings and continuously extruded sections in street lighting lanterns.

MEETINGS AND PAPERS

Association of Supervising Electrical Engineers

FARNBOROUGH
"Railway Electrification," by D. B. MacKenzie. Aldershot Branch. Queen's Hotel, Farnborough. Tues., 17 Feb., 7.30 p.m.

British Computer Society

LONDON
"Simulation of Melting Shop Operations on a Computer," by R. Neate. Northampton College of Advanced Technology, St. John Street, EC1. Tues., 17 Feb., 6.15 p.m.*

British Institution of Radio Engineers

EDINBURGH
"True Motion Radar," by J. H. Beattie. Scottish Section. Department of Natural Philosophy, The University, Edinburgh. Fri., 20 Feb., 7 p.m.
GLASGOW
"True Motion Radar," by J. H. Beattie. Scottish Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow C2. Thurs., 19 Feb., 7 p.m.

Central London Productivity Association

LONDON
Discussions on "Introducing New Methods." 21 Tothill Street, SW1. Thurs., 19 Feb., 2.30 p.m.

Chemical Society

GLASGOW
"Organic Crystal Chemistry," by H. M. Powell; and Annual General Meeting. Glasgow Branch. Chemistry Department, The University, Glasgow. Thurs., 19 Feb., 4 p.m.
NEWCASTLE UPON TYNE
"Recent Developments in the Chemical Applications of Nuclear Resonance Spectroscopy," by Dr. R. E. Richards. Newcastle upon Tyne Branch. Chemistry Department, King's College, Newcastle upon Tyne. Fri., 20 Feb., 5.30 p.m.
OXFORD
"Electrophilic Substitution of Nitrogen and Oxygen," by Professor Sir Christopher Ingold. Oxford Branch. Inorganic Chemistry Lecture Theatre, The University, Oxford. Mon., 16 Feb. 8.15 p.m.

Combustion Engineering Association

BIRMINGHAM
"Oil Burners for Small Steam Raising Plant," by I. G. Bowen, at 10 a.m., and "Supply, Storage and Handling of Oil Fuels," by A. Paterson, at 2.45 p.m. Midland Region. Chamber of Commerce, New Street, Birmingham. Wed., 18 Feb.
EDINBURGH
"Insulation of Industrial Buildings," by J. Lawrie, at 10.30 a.m.; and "Case Histories of Fuel Savings," by H. H. Grattidge, at 2.30 p.m. North British Station Hotel, Edinburgh. Wed., 18 Feb.

Diesel Engineers and Users Association

LONDON
"The Application of Diesel Engines to Automatically Controlled Power Plant," by K. L. Ives. Institute of Marine Engineers, 76 Mark Lane, EC3. Thurs., 19 Feb., 2.30 p.m.

Illuminating Engineering Society

LIVERPOOL
"Son et Lumière in Great Britain," by H. Hewitt. Liverpool Centre. Industrial Development Centre, Merseyside and North Wales Electricity Board, Liverpool. Tues, 17 Feb., 6 p.m.

Institute of Marine Engineers

BELFAST
"Metallurgy in Marine Engineering," by Dr. J. E. Garside. Northern Ireland Panel. College of Technology, Belfast. Tues., 17 Feb., 7.30 p.m.
CARDIFF
"Nuclear Steam Propulsion for Merchant Ships," by W. R. Wootton. South Wales Section. South Wales Institute of Engineers, Park Place, Cardiff. Fri., 20 Feb., 7 p.m.
NEWCASTLE UPON TYNE
Annual General Meeting. "Heavy Oil Burning," by Dr. J. S. Clarke and G. J. Hudson. North East Coast Section. Stephenson Building, King's College, Claremont Road, Newcastle upon Tyne. Thurs., 19 Feb., 6.15 p.m.*

Institute of Marine Engineers and Institution of Naval Architects

PORTSMOUTH
"Some Interesting Aspects of Model Test Work," by W. A. Crago. Southern Joint Branch. Portsmouth College of Technology, Portsmouth. Thurs., 19 Feb., 7.30 p.m.

Institute of Road Transport Engineers

LONDON
"Research on the Testing and Performance of Commercial Vehicle Brakes," by Dr. H. J. H. Starks. Royal Society of Arts, John Adam Street, Adelphi, WC2. Thurs., 19 Feb., 6.30 p.m.
LEEDS
"Disc Brakes and Independent Suspensions," by J. Pearson. Yorkshire Centre. Great Northern Hotel, Wellington Street, Leeds 1. Thurs., 19 Feb., 7.30 p.m.
MANCHESTER
"Servicing of Electrical Equipment," by H. J. Stoneman. East Regional Centre. Houldsworth Hall, 90 Deansgate, Manchester. Mon., 16 Feb., 7.45 p.m.

Institution of British Agricultural Engineers

LONDON
"Application of Electricity to Agriculture," by P. G. Finn-Kelcy. Tues., 17 Feb., 2.15 p.m.

Institution of Civil Engineers

LONDON
"Construction of a Large Experiment Tank at Haslar," by J. W. Hunter, A. C. Little and J. D. Halcon. Tues., 17 Feb., 5.30 p.m.*
BIRMINGHAM
"Civil Engineering Sight Seeing Abroad," by J. B. Menzies. Midlands Association. Civic Centre, Birmingham. Wed., 18 Feb., 6 p.m.*

Institution of Electrical Engineers

LONDON
"Ultrasonic Iconoscopes," by C. N. Smyth and J. Sayers. Radio and Telecommunication Section. Wed., 18 Feb., 5.30 p.m.*
"Measurement of Errors in Data Transmission for the Design of Detecting and Correcting Equipment," by V. J. Terry and E. P. G. Wright. Joint Meeting of the Radio and Measurement Sections. Fri., 20 Feb., 5.30 p.m.*
DUBLIN
"Appraisal of the Factors Apertaining to Reliable Television and Very High Frequency Coverage," by N. W. Mulcahy. Irish Branch. Physical Laboratory, Trinity College, Dublin. Thurs., 19 Feb., 6 p.m.
EDINBURGH
"Recognition of Moving Vehicles by Electronic Means," by T. S. Pick and A. Readman. South East Scotland Sub-centre. Carlton Hotel, North Bridge, Edinburgh. Tues., 17 Feb., 7 p.m.
LIVERPOOL
"Thermonuclear Processes," by D. W. Fry. Mersey and North Wales Centre. Royal Institution, Colquitt Street, Liverpool. Mon., 16 Feb., 6.30 p.m.
NEWCASTLE UPON TYNE
First Hunter Memorial Lecture on "P. V. Hunter: Electrical Engineering in Our Time," by C. O. Boyse. North Eastern Centre. Literary and Philosophical Society's hall, Newcastle upon Tyne. Wed., 18 Feb., 6.15 p.m.
PORTSMOUTH
"GPO Television Links," by T. Kilvington. Southern Centre. Offices of the Central Electricity Generating Board, 111 High Street, Portsmouth. Wed., 18 Feb., 6.30 p.m.*

Institution of Engineers-in-Charge

LONDON
"Air Conditioning" by H. J. G. R. Strudwick. Caxton Hall, off Victoria Street, SW1. Wed., 18 Feb., 6.30 p.m.*

Institution of Heating and Ventilating Engineers

MANCHESTER
"The Failure and Maintenance of Steam Boilers and Pressure Vessels," by C. W. Scarisbrick. Manchester Branch. Engineers' Club, Albert Square, Manchester. Fri., 20 Feb., 6.30 p.m.
SHEFFIELD
"Development and Application of the Underfeed Automatic Stoker," by K. Holdsworth. Yorkshire Branch. Grand Hotel, Sheffield. Wed., 18 Feb., 7.30 p.m.

Institution of Locomotive Engineers

LONDON
"Some Design Considerations of Main-Line Diesel Locomotives," by T. Schur. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, SW1. Wed., 18 Feb., 5.30 p.m.*

Institution of Mechanical Engineers

LONDON
Discussion on "The Pumping of Liquids of Unusual Viscosity, Volatility, or Solid or Gas Content." Hydraulics Group. Tues., 17 Feb., 6 p.m.*
"Experimental Study of Some Variables of the Tube Expanding Process," by L. E. Culver and Professor Hugh Ford. Meeting in conjunction with the Applied Mechanics Group. Fri., 20 Feb., 6 p.m.*
"Gyroscopes in Automatic Controls," by T. N. Dewey and J. E. Stephenson. London Graduates' Section. Thurs., 19 Feb., 6.30 p.m.*
CARDIFF
"Noise and Hearing: Physiological Aspects," by Professor W. Burns; and "Origins of Diesel Engine Noise," by A. E. W. Austen. South Wales Branch. South Wales Institute of Engineers, Park Place, Cardiff. Tues., 17 Feb., 6 p.m.
HULL
"Recent Developments in Propulsion Machinery" and "Refrigeration Equipment for Deep-Sea Trawlers," by G. C. Eddie. Yorkshire Branch. Royal Station Hotel, Hull. Wed., 18 Feb., 7.30 p.m.
PORTSMOUTH
"Some Experiments with Internal-Combustion Engines," by R. C. Cross. Southern Branch. College of Technology, Anglesea Road, Portsmouth. Wed., 18 Feb., 6.30 p.m.

Institution of Mining and Metallurgy

LONDON
"Geochemical Drainage Reconnaissance for Copper in Northern Rhodesia," by Dr. J. S. Webb and Dr. J. S. Tooms. Geological Society, Burlington House, Piccadilly, W1. Thurs., 19 Feb., 5 p.m.*

Institution of Production Engineers

LONDON
"Planned Maintenance of Electrical and Mechanical Equipment in a Paper Mill," by C. A. Castle and D. W. Bexton. London Section. Royal Empire Society, Northumberland Avenue, WC2. Thurs., 19 Feb., 7 p.m.
EDINBURGH
"The Production Engineer and Line Management," by J. Gloag. Edinburgh Section. North British Hotel, Princes Street, Edinburgh. Wed., 18 Feb., 7.30 p.m.
OXFORD
Discussion on "Machine Tools." Oxford Section. Town Hall, Oxford. Tues., 17 Feb., 7.30 p.m.

Institution of Public Health Engineers

LONDON
"Water Supply in East Kent: Some Engineering Problems," by J. L. Unitt. Caxton Hall, off Victoria Street, SW1. Thurs., 19 Feb., 6 p.m.*

Institution of Structural Engineers

GLASGOW
"Modern Trends in the Design of Steel Bridges and Structures," by W. R. Cox. Scottish Branch. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. Fri., 20 Feb., 7 p.m.

Institution of Water Engineers

LONDON
Film Display. South Eastern Section. Institution of Civil Engineers, Great George Street, SW1. Wed., 18 Feb., 2.30 p.m.

Junior Institution of Engineers

LONDON
"Selection and Use of Arc Welding Processes," by E. Flintham Fri., 20 Feb., 7 p.m.*

Manchester Metallurgical Society

MANCHESTER
"High Temperature Alloys," by D. R. Wood. Central Library, Manchester. Wed., 18 Feb., 6.30 p.m.

Modular Society

LONDON
"Modular Planning of Multi-storey Buildings at Kensal Rise," by Prof. Sir William Holford. Building Centre, 26 Store Street, WC1. Wed., 18 Feb., 6 p.m.

Reinforced Concrete Association

LONDON
"Precasting in Concrete Framed Construction," by J. F. Greining and R. C. Westbrook. 11 Upper Belgrave Street, SW1. Wed., 18 Feb., 6 p.m.*

Royal Aeronautical Society

LONDON
"Engine Starting Systems," by R. H. Woodall. Tues., 17 Feb., 7 p.m.
"Theoretical Studies of Guided Missile Systems," by E. G. C. Burt. Institution of Civil Engineers, Great George Street, SW1. Thurs., 19 Feb., 6 p.m.*

Royal Institution

LONDON
"Earth's Gravitational Field," by B. C. Browne. Fri., 20 Feb., 9 p.m.

Royal Meteorological Society

LONDON
Various short papers. Wed., 18 Feb., 5 p.m.*

Royal Society

LONDON
"Some Chemical Advances in the Ministry of Supply," by Sir Owen Wansbrough-Jones. Thurs., 19 Feb., 4.30 p.m.*

Royal Society of Arts

LONDON
"Rheology: The Science of Plastic Flow," by Professor E. G. Richardson. Wed., 18 Feb., 2.30 p.m.

Scientific Film Association

LONDON
Discussion on "Films in the Service of Industry: Some Observations by Industrial Film Uses." Shell-Mex House, WC2. Wed., 18 Feb., 6.30 p.m.

Sheffield Metallurgical Association

SHEFFIELD
"Why Are Steelmaking Reactions So Slow," by Dr. R. G. Ward. BISRA Laboratories, Hoyle Street, Sheffield. Tues., 17 Feb., 7 p.m.

Sheffield Society of Engineers and Metallurgists

SHEFFIELD
"Automatic Press Forging," by J. G. Wistretch and J. D. Stringer. Mon., 16 Feb., 7.30 p.m.

Society of Instrument Technology

NOTTINGHAM
Discussion on "Data Collection and Processing." East Midland Section. Nottingham and District Technical College, Shakespeare Street, Nottingham. Thurs., 19 Feb., 6.30 p.m.

South Wales Institute of Engineers

CARDIFF
"Trees, Pulp and Paper," by Dr. Theodore H. Frankel. Thurs., 19 Feb., 6 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this feature should reach the Editor not later than three weeks before the date of the meeting.

* An asterisk is placed where it is understood that refreshments are available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury Square, London, WC1. (LANgham 5927.)
British Computer Society, Finsbury Court, Finsbury Pavement, London, EC2. (MONarch 6252.)
British Institution of Radio Engineers, 9 Bedford Square, London, WC1. (MUSeum 1901.)
Central London Productivity Association. Apply to Mr. B. E. B. Turner, Shell-Mex & B.P. Ltd., 1 Kingsway, London, WC2. (TEMple Bar 8456.)
Chemical Society, Burlington House, Piccadilly, London, W1. (REGent 0675.)
Combustion Engineering Association, 6 Duke Street, St. James's, London, SW1. (WHItehall 5536.)
Diesel Engineers and Users Association, 18 London Street, London, EC3. (ROYal 2393.)
Illuminating Engineering Society, 32 Victoria Street, London, SW1. (ABBey 5215.)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, EC3. (ROYal 8493.)
Institute of Road Transport Engineers, 69 Victoria Street, London, SW1. (ABBey 6248.)
Institution of British Agricultural Engineers, 6 Buckingham Gate, London, SW1. (TATe Gallery 8589.)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (TEMple Bar 7676.)
Institution of Engineers-in-Charge, 13 Grange Close, Edgware, Middlesex. (MILl Hill 3543.)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, SW1. (SLOane 3158.)
Institution of Locomotive Engineers, 28 Victoria Street, London, SW1. (ABBey 6672.)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476.)
Institution of Mining and Metallurgy, 44 Portland Place, London, W1. (LANgham 3802.)
Institution of Naval Architects, 10 Upper Belgrave Street, London, SW1. (SLOane 4622.)
Institution of Production Engineers, 10 Chesterfield Street, London, W1. (GROsvenor 5254.)
Institution of Public Health Engineers, 118 Victoria Street, London,SW1. (VICtoria 3017.)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, SW1. (SLOane 7128.)
Institution of Water Engineers, Parliament Mansions, Abbey Orchard Street, London, SW1. (ABBey 6740.)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, SW1. (VICtoria 0786.)
Manchester Metallurgical Society, The Kennedy Press, Ltd., 31 King Street West, Manchester 3.
Modular Society, 22 Buckingham Street, London, WC2. (TRAfalgar 4567.)
Reinforced Concrete Association, 94-98 Petty France, London, SW1. (ABBey 4504.)
Royal Aeronautical Society, 4 Hamilton Place, London, W1. (GROsvenor 3515.)
Royal Institution, 21 Albemarle Street, London, W1. (HYDe Park 0669.)
Royal Meteorological Society, 49 Cromwell Road, South Kensington, London, SW7. (KENsington 0730.)
Royal Society, Burlington House, Piccadilly, London, W1. (REGent 3335.)
Royal Society of Arts, John Adam Street, Adelphi, London, WC2. (TRAfalgar 2366.)
Scientific Film Association, 3 Belgrave Square, London, SW1. (BELgravia 6188.)
Sheffield Metallurgical Association, 64 Crescent Road, Sheffield 7. (Sheffield 52865.)
Sheffield Society of Engineers and Metallurgists, University of Sheffield, St. George's Square, Sheffield 1. (Sheffield 24071.)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251.)
South Wales Institute of Engineers, Park Place, Cardiff. (Cardiff 23296.)

Design

FOUNDATIONS TO MINIMISE HEAVY VIBRATIONS

Construction Features in a Stamp and Press Shop

Fig. 1 A stamp line in the Hawker Aircraft factory at Blackpool. The foundations were designed to minimise vibrations. Moving masses in the stamps weigh between 30 cwt and 10 tons.

MANY valuable lessons in the design and construction of machine foundations can be learnt from recent work at the Squires Gate factory of Hawker Aircraft Limited, Blackpool. The site is flat and sandy, with an underlying stratum of peat extending for many miles and which is in turn underlaid by a very soft and deep stratum of unstable silt. In 1940 a large factory was built there for making Wellington bombers and during the Second World War several small side hammers were installed in the factory; their foundations vibrated strongly and settled badly, causing adjacent column footings to settle.

When a new hangar was built 400 ft distant from the main factory, using bored piles for the foundations, which usually do not induce nearly so much vibration as driven piles, the driving operations nevertheless did cause sufficient vibration to accelerate the rate of settlement of the spread footings beneath the reinforced concrete columns of the main factory. Forging hammer makers thought that it would be impossible to build any foundations for large hammers on such bad ground, since they believed that these machines would be hammered into the soft silt with practically unrestricted settlement. This would have been extremely serious for Hawker Aircraft because this geological structure extends for a radius of about 15 miles from the centre of the factory.

A 5,500 ton Shaw press and ten Ceco sheet metal stamps (made by the Chambersburg Engineering Company, Pennsylvania, USA, for whom Alfred Herbert and Company Limited, Coventry, are the agents), had to be installed. Each stamp has an anvil of solid cast steel, rectangular in plan, with four vertical steel legs carrying a bridge piece mounted at the ends. This bridge piece supports a double-acting compressed air cylinder, the piston of which is fixed to the hammer; the hammer frame slides in vertical guides attached to the legs of the stamp. Heavy metal dies for making aircraft components are fixed to the anvil and hammer in each case; these ten stamps have upper total moving masses weighing from 30 cwt to 10 tons, the largest machine having an overall weight of 60 tons (Fig. 1).

Although the impact velocity of the tup is reduced to some extent by valve gear, this does not in any way simplify the problem of vibration control, because the weight of the anvil is proportionately reduced. A heavy shock wave results, because metal dies are often employed, and forging is always done on cold metal; the shock wave had therefore to be insulated from the concrete foundation, or the latter would have been broken. It was decided that suitably designed rubber springs would give the best results, but in order to reduce live load from the anvil to a minimum, two requirements had to be fulfilled, namely: the shock wave be reduced by refraction and reflection by the respective boundaries, according to the number of layers of springs used, each spring comprising a sandwich of rubber vulcanised between two steel plates; and secondly, as a result of the blow, the anvil be set into some specially chosen simple harmonic motion on these rubber springs. It is essential that the frequency of this simple harmonic motion should be substantially out of resonance with the natural frequency of the ground in order to avoid any possibility of the live load and amplitude building up. The lowest frequency permitted for the largest stamps was 2½ c/s., which compares very favourably with a natural frequency of about 13 c/s. for the surrounding silty clay.

The additional expenditure involved in providing vibration controlled foundations would be fully justified if heavy stamps could be mounted on the site without being hammered into the ground, and if vibration could be effectively isolated so that no additional damage due to settlement would be inflicted on the main factory. A further problem arose from the compressed air installation. For aircraft manu-

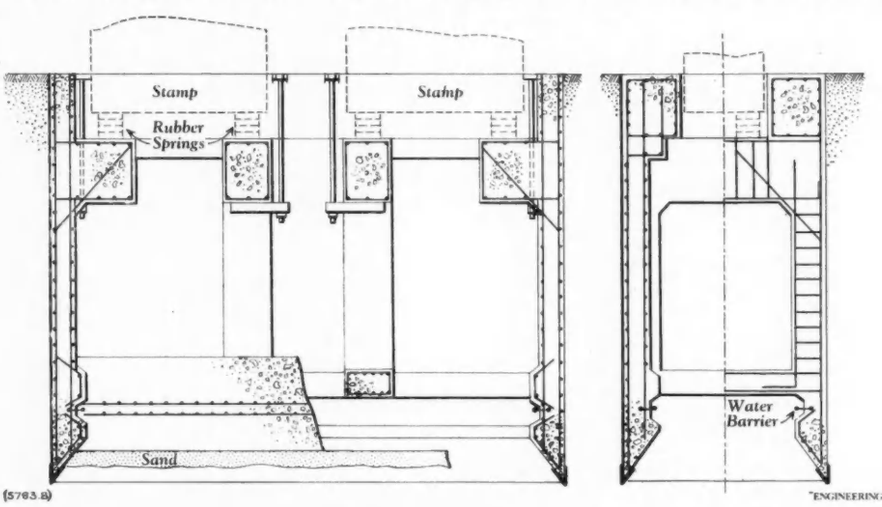


Fig. 2 Open-well caisson foundations adopted for the stamps.

Fig. 3 Lockheed dead-beat foundation dampers as used under the stamps.

facture, ring mains are required to supply the large number of riveters and other air tools employed; in this case there are six Broomwade air compressors of two-cylinder design, driven by electric motors, with stand-by diesel engines provided for emergencies. There are also two stand-by alternators for generating electric power, driven by large diesel engines. Existing plant of this type was causing heavy ground vibrations; the compressors were mounted on 2 in of cork during the war, but the water table was only 2 ft below ground level, with the result that the cork was saturated, its resilience was practically negligible, and the vibrations travelled two miles.

SITE SURVEY

Comprehensive site testing was undertaken by Ground Explorations Limited and six boreholes were put down in order to obtain samples. It was revealed that the entire site of the factory and airfield was flat; there is a uniform top sand stratum 10 ft thick, followed by 5 ft of peat. Below these two strata is a 15 ft layer of soft silty clay beneath which is a 10 ft thickness of sand; the only firm soil is boulder clay at a depth of 40 ft.

The soft silty clay could withstand about 0·9 ton per sq. ft extra load before failing in shear, so that if a factor of safety of 2·5 be assumed, the allowable increase in pressure would be about 0·35 ton per sq. ft with the depth factor added. Since the transient load on the hammer foundations would be greater than the dead load, this load was estimated to be 0·50 ton per sq. ft because experience has proved that if this shear stress is increased by repetition of load, gradual failure of the ground will occur due to plastic flow.

The rate of settlement was estimated as likely to be relatively rapid. Settlement rate for the 10 ft thickness of soft silty clay is given below, on the assumption that the coefficient of consolidation is 9·4 sq. ft per annum:

Percentage of total settlement	Time in years
25	0·1
50	0·4
75	1·1
95	2·5

From which it will be seen that settlement would be practically complete in two or three years.

The firm carrying out the above tests gave the opinion that drainage of the silty clay by ordinary pumping would not be practicable owing to its particle size distribution and the liquid and plastic limits. Nevertheless, it was also stated that for soil retaining structures, such as sheet piling, great advantage would be gained by draining water from behind the latter; this applied both to the soft silty clay and to the underlying sand. It was considered that in the top strata of sand and peat it would be possible to lower the water table by the established technique of well point pumping, but that the silty clay and the underlying sand were of such a nature that they could successfully be drained by electric osmosis. This was rejected because of its high cost.

DYNAMIC CHARACTERISTICS OF BUILDING AND PLANT

The stamp shop is accommodated in a war-time Belman hangar of light structural steel covered with corrugated steel sheeting, its footings consisting only of steel troughing buried in the ground below the stanchion bases to a depth of 9 in. The adjacent hangar has exceptionally heavy long open steel trusses strengthened by wind bracing, with pin jointed legs at one end and covered with steel sheeting; the foundations are supported on heavy piles driven to a considerable depth.

For dynamic soil testing, a tup weighing 2 cwt was dropped on to a concrete slab well bedded into the ground near the hangar. The natural frequency of the top sand stratum was found to be 19 c/s, a figure consistent with the fact that the top of this stratum is fairly dry. Further away this frequency falls to 17·3 c/s and it was considered that this was the frequency to which any near-by building foundation was likely to be subjected.

The next test consisted of dropping a 2 cwt tup in the test borehole for a depth of 22 ft on to the soft silty clay, when its natural frequency was found to be 13 c/s, thereby indicating that any sudden impulses from deep machine foundations will generate at remote distances the two dominant frequencies of 17 and 13 c/s, above and below the peat respectively. The natural frequency of each of the main buildings was also measured; the Belman hangar used for the new stamp shop had a natural frequency of 10 c/s for its roof, and of between 14 and 15 c/s for the building as a whole. The roof girders of the main hangar had a natural frequency of 11·6 c/s

Dynamic characteristics of the main factory building were not measured because of its large size and structural complexity. Just within this building, about 450 ft distant from the impact test using a 2 cwt tup, the amplitude of the ground vibration was less than 0·001 in, with frequencies ranging from 17 to 13 c/s. Rate of diminution of ground vibrations was measured and was found to be slightly less than for an average clay stratum.

The natural frequencies of all the buildings were within the same range as the natural frequencies of the top stratum; in other words, there was a condition of near resonance. If traditional foundations had been used on this site, a large block of concrete would have been provided for each stamp, and it would have had to be taken down to a firm bottom.

Brief calculations revealed that the maximum amplitude of ground vibration at the point of the main building nearest to the 10 ton stamps would be about 0·0002 in, just on the threshold of human perception. Although any vibration would probably increase the rate of settlement of this building and therefore certainly increase its maintenance cost, such a very small vibration as this would scarcely have any influence upon the rate of settlement of the main building foundation. The strong hangar with the piled foundations would be subjected to considerable vibration from the sheet metal stamps because it is very close to them, but experience proves that soil vibration tends to tighten the ground around piles, thereby improving their bearing capacity. On the other hand, it was considered that underpinning of the Belman hangar would be essential, because otherwise it would settle very considerably, there being almost no foundations. Conventional mass foundations were ruled out from the very start. Piles had been used successfully on this site for static foundations, but experience has proved that they are unstable for machine foundations like stamps and hammers because of their lateral instability. Moreover, the owners expressed concern about the possible damage which could result from ground vibrations induced by pile driving and by the stamps themselves. Many components of the Hawker Hunter aircraft are assembled with the aid of very precise jigs, using tall heavy cast iron and concrete pedestals and columns, across which are stretched taut steel wires. Ground vibration causes these heavy columns to oscillate and the taut steel wires to vibrate strongly; in view of the fact that this type of jig is peculiarly susceptible to vibration, a method of pile driving was selected which had been proved by experience to cause little ground vibration. This is the piling system developed and sponsored by West's Piling and Construction Company Limited.

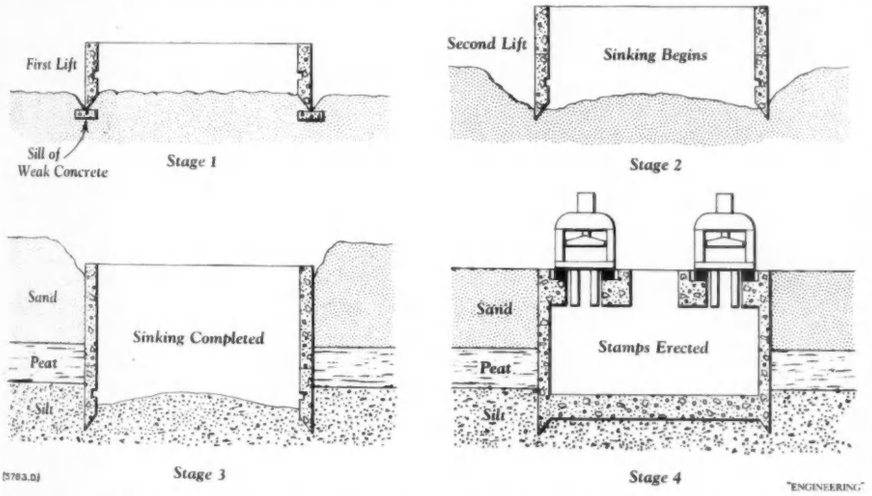


Fig. 4 The four stages in sinking the caissons for the stamps.

It was considered that vibration due to piling could be kept under control with the aid of a Crockett vibrograph set up in the aircraft assembly shop. The directors of Hawker Aircraft were adamant that their company should receive complete insurance compensation for any damage or even failure of aircraft arising from piling work, but the insurance company holding the piling contractor's insurance policy was not prepared to underwrite this risk. When the matter was placed before the Ministry of Supply, it was decided that the Ministry would accept the risk under the exceptional circumstances of this case. In fact, an investigation showed that the vibrations caused by piling were considerably less than those arising from the normal manufacturing process of riveting; vibrations set up in templates and taut wires were greater from riveting than from piling.

During pile driving it was found that the toe resistance provided nearly all the bearing capacity of the piles, since there is very limited frictional resistance from the sides of the piles. West's Rotinoff piles with a diameter of 17 in were employed, of which 14 were raker piles and 63 were vertical, most of them having been calcuated to take a load of more than 30 tons each.

The Belman hangar is 175 ft long and 95 ft wide, the old foundations of steel troughing being set 9 in below ground level. The original war-time blast walls were removed and the piles were driven near the middle of each bay; there was one vertical pile and one raker pile in

Continuing **Design**

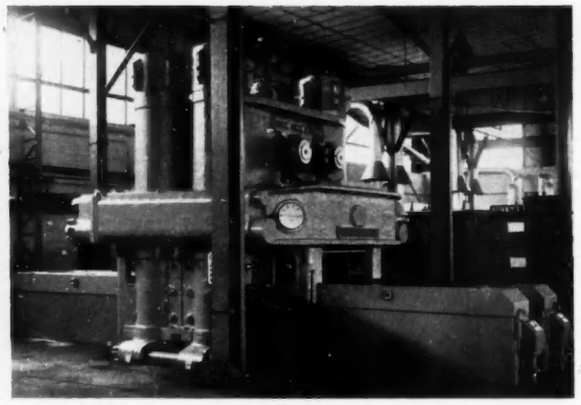


Fig. 5 The 5,500 ton Shaw press installed in the works.

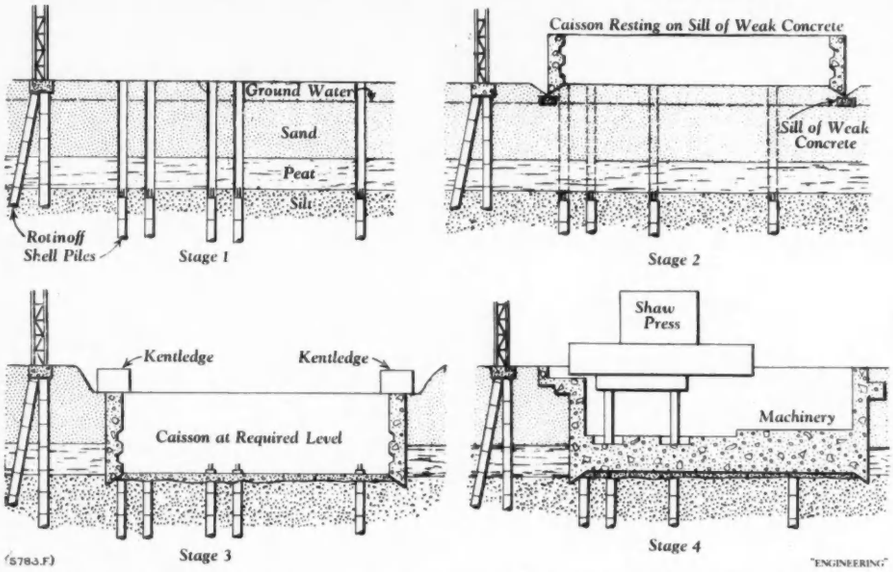


Fig. 6 Stages in foundation construction for the Shaw press.

alternate bays to take wind loads. The angle of rake is 15° to the vertical; a cast-in-situ ground beam of reinforced concrete was laid on top of the piles, picking up all the bases of the stanchions.

FOUNDATIONS FOR STAMPS

After very careful and detailed consideration of various alternative proposals, it was finally decided to adopt the open-well type of foundation for all the stamps, like caissons without tops, details of which are shown in Fig. 2 for one of the four wells. Each stamp is supported at each end by multiple-sandwich Andre rubber spring assemblies, each plate of the latter held in position by holding-down bolts of $\frac{3}{4}$ in diameter, additional vibration control being provided by Lockheed hydraulic deadbeat foundation dampers as shown in Fig. 3.

The reinforced concrete walls of the open wells were generally cast in three successive lifts, stiffening taking the form of vertical portal frames, the legs of which are 18 in thick from outer to inner faces, and 1 ft 9 in wide. The top members of these frames have been designed both as struts to withstand lateral earth pressure from each side, and also to carry the rubber springs upon which the anvils rest.

There is a large horizontal dovetail immediately above the cutting toe forming a key for the concrete floor of the well, spreading the load over the base of the foundation. All construction joints have a water barrier of pvc material made by Expandite Limited. After sinking the wells to the required depth, and after the tops of the portal frames had been cast monolithically with the top lift of the walls, the stiffening ring beam was cast, with its top surface flush with the finished floor level of the reconstructed stamp shop (Fig. 4). In the design the dead load of each foundation only is just slightly heavier than the buoyancy effect of the water in the ground, with the result that these foundations are almost weightless and so impose practically very little stress upon the underlying silty clay, due allowance having been made for the effect of depth.

All reinforced concrete was carried out in accordance with BS Code of Practice No. 114 and all concrete was vibrated; samples of aggregate and sand were approved by the consulting engineer. It was specified that Lee-McCall stressing bars and jacks were to be employed for controlling distortion of the wells. Such distortion would consist of complete twisting of the wells during sinkage, before the floor or base had been poured. Fig. 4 shows the four stages in building a foundation.

The rubber springs and Lockheed dampers (Fig. 3) were erected on the cross beams, which were designed with great care to support the heavy loads imposed upon them. The dampers were anchored to the beams by Lee-McCall stressing bars, which were jacked down into tension, the load being adequate to counteract effectively any tendency for their baseplates to lift; each damper exerted a maximum tensile load of [illegible] tons. Ground vibrations are barely perceptible at about 150 ft from the stamps.

PRESS FOUNDATIONS

Another foundation problem was presented by the 5,500 ton press made by John Shaw and Sons of Salford (Fig. 5). This press is carried by four legs of structural steel, each carrying a maximum load of 120 tons, with a complete engine room below floor level accommodating two-stage compressors and an hydraulic intensifier, with elaborate valve and control gear. No measures were taken to avoid shock impulses being induced in the ground by this machine because shock loads occur only a few times each day.

It was necessary to drive bearing piles for the foundation to a depth varying from 50 to 60 ft, each carrying a minimum load of 50 tons, these piles so distributed as to carry both the point loads from the stanchions forming part of the press superstructure, and also the foundation pit which forms the engine room (Fig. 6).

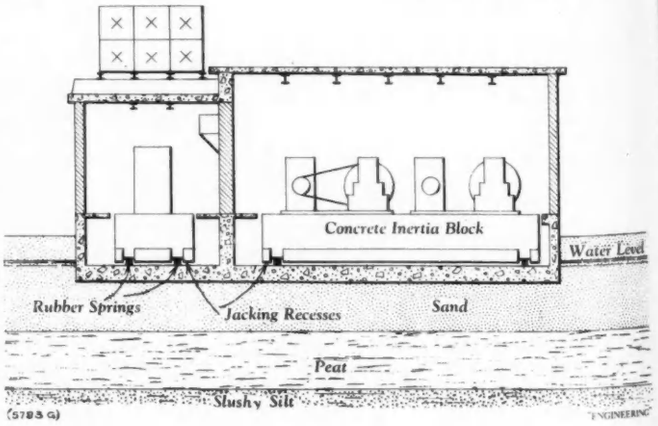
In due course the ground water escaped through the peat so that the top stratum of sand settled and closed in upon the well, nipping it tight. The structure was moved again and maintained reasonably level by a combination of jetting and kentledge. When the well had reached the required level in the silt, the base of the structure was concreted in three bays, using preformed layers of steel reinforcing mats.

ENGINE HOUSE

There are three engine houses, each accommodating two Broomwade two-stage air compressors driven by electric motors, with an additional stand-by diesel-driven set in each case. In a second room in two of the engine houses there is an alternator driven by a large diesel engine. It was recommended that piles should not be used for these foundations because of their unsatisfactory resistance to lateral vibration. Each engine unit was therefore mounted on a vibration controlled inertia block within a foundation pit, as shown in Fig. 7. The weight of the inertia block is 180 tons and each is made of 1 : 2 : 4 concrete with a small amount of steel reinforcement, but with Ductube passages left for Freyssinet stressing cables; these were suitably post stressed with hydraulic jacks and anchored by Freyssinet cones in the manner which has now become standard practice.

These inertia blocks are complete structural units; after their concrete had been poured, they were raised by jacking and large rubber springs were inserted below them, providing a vibration controlled system having a natural frequency well below the frequency of the compressors at their normal speed. They have strong out-of-balance forces at 7·1 c/s. and at double this frequency, namely 14·2 c/s.

Fig. 7 Resilient foundations for the compressor installation.



The rubber springs were therefore selected to have a spring constant under full dead load which would give a frequency of about 2·3 c/s vertically, and a frequency much lower than this in the horizontal and rotational modes of oscillation. When both the machines were running together, with the stand-by diesels also operating, ground vibrations were perceptible at a maximum distance of about 80 ft from the machinery, which compares very favourably with a reported distance of one mile when the machines had been previously mounted on traditional foundations. The stand-by alternators and diesel engines were also mounted on concrete inertia blocks, each weighing about 30 tons and mounted on rubber springs; the natural frequency of this block in all six degrees of freedom is about 4 c/s. The vibration control provided was very much greater than it was for the compressors, and it was practically impossible to discern any ground vibrations, even when standing alongside the block with the set running at normal speed.

Special care was taken to avoid cracking of the 180 ton concrete inertia blocks due to excessive rise of temperature during setting. The block was kept cool internally by the simple expedient of passing a slow trickle of water from a hosepipe through various holes in the concrete, to maintain the temperature below 140° F.

In this case the entire building with the vibration controlled foundations are balanced, the building being kept high in order to increase the depth of sand below the raft foundation and thereby to prevent punching through the sub-soil. Water has been squeezed out of the peat, and such settlement as has occurred has been even.

The work was undertaken for the Hawker Siddeley Group, the consulting engineers being J. H. A. Crockett and D. B. O'Neill. The architects were Norman and Dawbarn. The general contractors were Sir Lindsay Parkinson and Company Limited, the engine houses and their foundations being built by Ides Limited.

BRIGHT LIGHTS

for Birmingham Ring Road

A new type of post-top lantern conceived by Birmingham's Public Works Department under the direction of Sir Herbert J. Manzoni, C.B.E., City Engineer and Surveyor, will give the city's new inner ring road, now under construction, a higher intensity of illumination than any other roadway in Britain.

The road is to be lit to a standard comparable with the city's main shopping centre where the light of the lanterns in the lower hemisphere is about 30,000 lumens per 100 ft of roadway. In addition, in order to avoid the unsightly appearance of a forest of poles, columns are to be erected on the outer kerbs only, in pairs, and exactly opposite each other at intervals of 100 ft.

Lantern illuminated at night while being tested at the GEC Witton Works, Birmingham.

Lantern with dished bowl lowered to its full extremity allowing easy access for cleaning and lamp replacement.

The desired standard of lighting under these conditions could only be reached by a unit with a very high light output. Many forms of high intensity lighting, installed both in Britain and on the Continent were considered before it was decided to develop a new type post-top unit housing three 400 watt colour corrected mercury lamps.

The Lighting Division of the General Electric Company Limited co-operated in developing a prototype, and an order for 100 lanterns has already been placed with the GEC.

Mounted on slender steel poles, 30 ft high, the lanterns are 4 ft 6 in in diameter, about 18 in deep and comprise a domed canopy and dished translucent Perspex bowl. The light output from the lanterns will be approximately 36,500 lumens.

Access to the three lamps for cleaning and lamp replacement is simple. The bowl can be released and easily pulled down to the extent of 18 in where it is held by counter balancing weights.

The columns have long bases to accommodate three sets of control gear and time switches. Many of the columns will be erected on viaducts and in parapet walls adjacent to subway entrances, the construction of which precludes the installation of columns with normal roots. For such positions special bases have been designed to fit in with the structural work.

MACH 5 TRAVEL BY 1970 ?

American thinking on the supersonic airliner has been summarised recently by Mr. R. C. Sebold, vice-president of engineering for Convair Division of General Dynamics Corporation, at the Institute of Aeronautical Sciences Symposium on Aero/Space Technology. Passenger transport aircraft flying at three to five times the speed of sound and available in 1970 are a much more likely prospect than the Mach 2 airliner which could be delivered by 1965, he suggested.

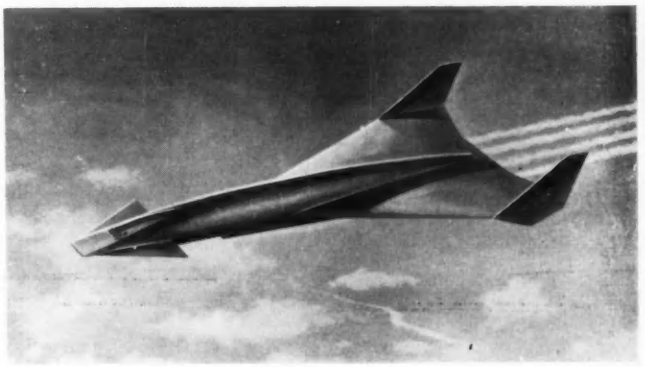
In his appraisal of "Commercial Air Transportation Beyond the Subsonic Jets," Mr. Sebold said that exhaustive studies by Convair engineers had shown the Mach 2 transport to be competitive with all existing aircraft—"a certain money maker, a good airplane in every sense"; but it does not appear probable "an airline would finance new Mach 2 equipment on the strength of a five-year advantage." The Mach 3 to 5 transport should have an operational life of 15 to 20 years, or longer.

Convair have evaluated more than 100,000 supersonic aircraft design parameters, and have devoted more than 10,000 hours of wind tunnel testing to the more promising configurations.

Mach 3 and 5 transport aircraft will be required to fly at subsonic speeds below approximately 35,000 ft to avoid "public irritation and property damage." Because they must climb up to and let down from, the supersonic cruising altitudes at subsonic speeds, there is a practical limit to the advantages of high speeds. For example a transcontinental transport designed for cruising at Mach 7 probably would never attain that speed in flight. "It would accelerate out to cruising speed only to find that it must immediately start deceleration to land . . ."

In discussing the shape of the transports of the future, Mr. Sebold said such aircraft "probably will fit into a box 30 to 50 ft high, 70 to 120 ft wide and 170 to 230 ft long." He showed charts that indicated the aircraft would not be radically different in external shape from today's advanced military aircraft. Structurally they will be sharply different, because of the heat generated by aerodynamic friction on the aircraft's skin surfaces. Cooling the Mach 3 to 5 transport cabin interior by methods conventional today would require cabin walls a foot thick, or a gale of air blowing through the cabin area even if a source of cool air were available. One suggested solution is to cool the cabin walls with circulating water.

Methods of pressurising cabins at the 60,000 ft and higher altitudes at which Mach 3 to 5 transport will cruise also will create formidable design problems. Such systems must be absolutely fail-safe. Towards this end, transport aircraft of the future may be windowless, in the interests of greater structural strength. This suggests the possibility of television screens, remotely controlled to provide passengers with a view of the outside world.



This tail-first configuration is one of hundreds of design studies by Convair for a Mach 3-5 airliner. It is windowless for structural strength.

Book Reviews

REVOLUTION IN POWER

A History of Technology. Volume V: The Late Nineteenth Century. Edited by CHARLES SINGER, E. J. HOLMYARD, A. R. HALL and TREVOR I. WILLIAMS. *Oxford University Press, Amen House, Warwick Square, London, EC4.* (168*s*)

In the last paragraph of the four thousand-odd pages of this great work, Sir Alexander Fleck reminds us that the central feature of the Industrial Revolution was, and continues to be, a revolution in power. This revolution has taken place not only in the power of the machine, but also in that of employers and of labour, in the economic power of nations and in the power of armaments. Man, in the age of nuclear energy, can less than ever before ignore the truism that power in itself is neither good nor evil, except as it is used..

This vast growth of power was made possible during the period covered by the final volume of this history by the development of transport and communication systems which enabled enormous movements of population to take place, new nations to emerge, and industries to be concentrated in space and ownership on an unprecedented scale. The process has continued at an even faster pace in the 20th century, into which the editors have not ventured; partly because, as they explain, of the increasing difficulty of describing recent technological developments sufficiently shortly and simply for the general reader.

At the opening date of this volume the Industrial Revolution in Britain was far from complete. The largest number employed was still in agriculture with 1¾ millions, while domestic service followed with 1 million. Building came third with just under half a million and there were still more tailors than railway workers and 50 per cent more blacksmiths than iron workers. By the end of the 19th century, there had been a substantial growth of mass-production consumer-goods industries, especially in soap and foodstuffs and cheap transport; gas and electricity were beginning to destroy the brutishness of existence which the masses had experienced from time immemorial. At the same time, a change took place in those social attitudes which had tolerated the cruelty and hardship of child labour and filthy rural cottages in the 18th century, and the early horrors of the Industrial Revolution in the next century. In part of the world, at least, the possibility of solving the age-old problem of poverty had arrived; while the growth and concentration of populations and improvements in the techniques of large scale printing ensured that democratic pressures would insist on the new possibilities being utilised to the full.

In this volume the editors have relaxed their self-denying ordinance sufficiently to include three sociological chapters: on education by Sir Eric Ashby, on industrial organisation by Mr. Charles Wilson, and on the social consequences of technology by Sir Alexander Fleck. Inevitably these are largely concerned with the relative decline of Britain in the era when empirical methods were giving way to the new scientific techniques, especially in the rising industries of chemical manufacture and electricity. The story of this decline and of the committees and commissions which were appointed to inquire into it has often been told. In the Great Exhibition of 1851, Britain had won awards for inventions in nearly every class; at the Paris Exhibition in 1867, she could claim a bare dozen. What had happened to the inventive genius and commercial initiative of British industry? Why was Britain so slow to realise the need for scientific and technical education, and for a system of primary and secondary education for all on which alone it could be based?

One explanation is in the traditions of a ruling class which determined the patterns of the only schools that existed and which despised the teaching of science as suitable only for manual workers. Because of the relative mobility of the British class system, the sons of business men could aspire to rise in it and so made their standards those of the landed gentry. Thus many of them lost their interest in industry and acquired a contempt for the practical arts. By contrast, the German business man, kept in his place by a much more rigid caste system, established his own standards and developed a prestige among the middle class for his own occupation.

Furthermore, on the Continent, governments faced with the task of catching up with Britain, did not hesitate to participate in the ownership or financing of basic industries or to establish systems of education which would produce the engineers and scientists required. Their industries were consequently built up on more scientific lines at a time when in Britain there was already a large accumulation both of capital investment and of traditional method in the older industries; while investors were finding it more profitable to finance the growing consumer goods industries supported as they were by extensive advertising campaigns.

Basically, however, the national backwardness in education was the main drag on Britain's industrial progress. Prussia had had a system of compulsory education since 1826; while Britain had none until 1870. On the Continent, the universities had research laboratories which acted as nurseries for the chemical industry and many technical universities were well established by the middle of the 19th century. In Britain, research was despised in the universities and there was little technical education until the " whisky money " was made available for it in 1890. This was of great importance because it was not industry which created the demand for the scientific specialist, but the growing complexity of scientific discovery which forced firms abroad and, in the end, at home to employ them if they wished to continue in business. Unfortunately, there are still too many industries which continue to rely on traditional methods and refuse to recognise the changing world in which they operate. Only in the last few years has the general public begun to realise some of these facts and to understand the level of education demanded by the scientific revolution that has taken place in technology.

To this new climate of opinion these volumes should make a valuable contribution and every credit is due both to their authors, their editors, their publishers and their sponsors, Imperial Chemical Industries. For the teacher of scientific or technical subjects they form a wonderful work of reference. They are, however, very expensive and if they are to find their way, as they should, not only into the universities but also into the library of every secondary school, technical and teachers' training college, then a cheaper edition will certainly be needed. It might even pay the Government to provide an additional subsidy for this purpose.

AUSTEN ALBU

CAST IRON

Hochwertiges Gusseisen (Grauguss). By EUGEN PIWOWARSKY. *Springer-Verlag, Reichpietschufer 20, Berlin W. 35, Germany.* (135 *DM*)

This renowned work on cast iron appeared in its second edition in 1951. For the past few years, the book has been out of print and sorely missed. The present (1958) reprint of the second edition contains 1,063 illustrations and 1,070 pages. In twenty-seven chapters, this massive work covers structure and properties, influence of elements and gases, crystallisation, heat treatment, hot and cold working and welding. Cold and hot blast cupolas are treated in detail and there is also a chapter on other types of melting units. The 70-page chapter on applications of cast iron is of special interest because it contains a wealth of information (it could in fact be a book in itself) on the most important uses of cast iron and not only gives details of analyses and mechanical properties, but also emphasises the main features required in an iron for a specific purpose and even recommends optimal wall thicknesses.

A specially useful feature of this standard reference work is the bibliographies after each sub-section of a chapter. Although the book does not deal with foundry practice (sands, moulds, cores, automation, etc.), it is an essential work of reference for foundry managers, metallurgists, users of cast iron and students of the metallurgy of cast iron able to read German. The final index is excellent. R. SEWELL

TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Safety

Breathing Apparatus. SIEBE, GORMAN & CO. LTD., Neptune Works, Davis Road, Chessington, Surrey. 200-page catalogue of safety breathing apparatus for dangerous situations. Self-contained equipment, head and eye protectors, fire appliances, first-aid outfits, gas samplers, etc.

Dust Protector. PANORAMA EQUIPMENT LTD., 29/36 Seymour Mews, Wigmore Street, London, W1. Semi-mask (mouth and nose) for fine dust filtration, down to 0·5 to 5 microns. Leaflet.

Traffic Barrier. R. B. PULLIN & CO., Phoenix Works, Great West Road, Brentford, Middlesex. Traffic control arm and curtain barrier up to 16 ft in length. Raised and lowered by an electric motor. Folder.

Noise. AMPLIVOX LTD., 2 Bentinck Street, London, W1. Booklet by Mr. A. E. Stevens on methods of calculating noise level and describing its effects on workers.

Eye Shields. FLEMING SAFETY EQUIPMENT, 146 Clerkenwell Road, London, EC1. Spectacles, goggles and eye shields for protection against dust or welding arcs. Special types for use when spectacles are normally worn. Supplement to catalogue 156.

Fire Protection. THE MATTHEW HALL GROUP, Matthew House, Dorset Square, London, NW1. Automatic sprinkler equipment, alarm heads and control valves. Illustrated brochure shows examples of installations and gives details of items.

Clothing Monitor. EMI ELECTRONICS LTD., Hayes, Middlesex. Hand and clothing monitor for detecting simultaneously alpha and beta contamination of the hands, with separate probes for the clothing enabling three people to use the instrument at once. Descriptive leaflet.

Fire Proofing. UAM GROUP OF COMPANIES, Tolpits, Watford, Herts. Structural fire protection in buildings is described in issue No. 4 of the group's information bulletin.

PRACTICAL BIAS

Thermodynamics of Heat Power. By VIRGIL MORING FAIRES. A revised edition of **Theory and Practice of Heat Engines.** *Macmillan Company, 60 Fifth Avenue, New York 11, N.Y., USA.* ($7); and *Macmillan Company, 10 South Audley Street, London, W1.* (56*s*)

The text under review is a revised edition of a book published previously under the title *Theory and Practice of Heat Engines*; it is intended for "students other than mechanical engineering majors."

The book is, in the main, a re-arrangement of the material of the previous edition. Chapters on gas turbines and gaseous mixtures have been added, together with an appendix containing a useful collection of property tables and charts. A bibliography appears at the end of many chapters and the book is well indexed.

The author claims to have adopted the modern concept of thermodynamics, "the logical and unified" approach, and to have shifted the major emphasis toward the development and application of theory. These objects have not been achieved. The method used in the later chapters of treating broad groups of essentially similar engineering plant as applications of common basic principles is not preceded by a rigorous and logical treatment of those principles. At the outset the reader is assumed to have an intuitive appreciation of "energy"; internal energy and the mechanical equivalent of heat are introduced before the (very brief) discussion of the First Law; entropy is discussed not as a consequence of, but as an introduction to, the Second Law.

The general approach to all analyses in this book is to regard the system properties internal energy and enthalpy, and the boundary interactions heat and work, as "energy." This broad use of the term "energy" is, in the reviewer's opinion, neither necessary nor helpful; energy is characteristic of a system, not something which happens to it. Indeed, in places the author seems to share this view; see for example his definition of heat: "energy in transition (moving) from one body or system to another because of a temperature difference between the bodies or systems," and the associated footnote which deprecates the use of the term heat when internal energy is intended. This latter confusion of ideas, which is prevalent still in the writings on, and in the teaching of thermodynamics is retained in the later chapters of this book in the use of such phrases as "the heat lost by the steam is stored in the material of the cylinder."

The treatment of combustion processes is not by way of a logical and unified approach and consequently retains some of the misconceptions associated with combustion and heat. For example, in the expression for the efficiency of open-cycle gas turbines and other internal-combustion engines, the denominator is given the symbol Q_A, for "heat added," and is referred to as "the energy chargeable against the system" and "the heat rate."

In the treatment of applications much valuable information of a practical nature is given. The full descriptions and the clear diagrams would be of considerable help to the student who is not familiar with the construction of modern engineering plant. The repeating of diagrams close to the text to which they refer, to avoid continual reference back, and the marking of each important equation with the restrictions applicable to it are features to be commended.

Summarising, it may be said that this book is useful for its practical bias rather than for its treatment of fundamentals and consequently is recommended only to those students who have already a firm grasp of principles.

E. H. COLE

The Reviewers

Mr. Austen Albu, M.P., B.Sc., A.M.I.Mech.E., M.I.Prod.E., is one of the few members of the House of Commons combining professional engineering qualifications with membership of a trade union, the AEU.

Mr. R. Sewell, who is a Fellow of the Institute of Information Scientists, is information officer in the research and development department, United Steel Companies Limited. He was a member of the British Iron and Steel delegation to the USSR in 1956, and was responsible for the English version of the *Metallurgical Classification* of the Centre de Documentation Sidérurgique and for the basic work on corrections and additions for the 1958 edition of the *Stahleisen Wörterbuch* (iron and steel dictionary) published by the Verein Deutscher Eisenhüttenleute. Since its inception, Mr. Sewell has been chairman of the British Iron and Steel Industry Translation Service.

Mr. E. H. Cole, B.Sc.(Eng.), A.M.I.Mech.E., A.C.G.I., Wh.Sc., is a lecturer in mechanical engineering at Imperial College, University of London.

NEW BOOKS

Technical Reports of the Electrical Research Association, *Thorncroft Manor, Dorking Road, Leatherhead, Surrey.*

"Shunt Capacitance Switching. A Review of Published Information," by D. Worth and P. H. G. Crane, G/T314 (18*s*); "Theoretical Calculation of Arc Temperatures in Different Gases," by L. A. King, G/XT155 (12*s* 6*d*); "Steels for Use in Steam Power Plant Operating above 950° F: Creep, Stress Relaxation and Metallurgical Properties," J/T170 (36*s*); "A Spectroscopic Investigation of Short Duration, High Current Sparks in Hydrogen," by P. Ravenhill, L/T353 (15*s*); "System Stability. Results of Full Scale Tests at Cliff Quay Generating Station," by F. Busemann, V/T135 (24*s*); "Dispersion Meter, Model 2A. Instruction Manual," V/T135 (12*s* 6*d*).

The Pump Users' Handbook. Compiled on behalf of The British Pump Manufacturers' Association by HERBERT ADDISON. *Sir Isaac Pitman and Sons Limited, Pitman House, Parker Street, Kingsway, London, WC2.* (30*s*)

This is a sort of pump-users' "home doctor" designed to give confidence to the user but not enough to encourage him to put right what can only be done by an expert.

Radio Engineering Formulae and Calculations. By W. E. PANNETT. *George Newnes Limited, Tower House, Southampton Street, London, WC2.* (17*s* 6*d*)

A compact volume apparently designed as a memory-jogger rather than a book on instruction.

Elementary Telecommunications Examination Guide. By W. T. PERKINS. *George Newnes Limited, Tower House, Southampton Street, London, WC2.* (17*s* 6*d*)

Covers the two main subjects of the City and Guilds Institute first year telecommunications course. Questions and model answers.

Handbook of the Petroleum Industry. Edited by G. SELL and H. A. DOSSETT. *George Newnes Limited, Tower House, Southampton Street, London, WC2.* (25*s*)

Written with a view to encouraging young people to "enter oil." There is no hint of "talking down" to the audience.

On the Shelf

By Frank H. Smith

The Council of the Trade and Technical Press, of Imperial House, Kingsway, London, WC2, has produced (for distribution through the Central Office of Information) a most useful booklet with a cover like Joseph's coat. It is "Business and Specialised Publications of Great Britain" and runs to 111 pages plus a "further details please" tear out. After a little preliminary chat on the scope and function of the trade and technical press, the publications are listed, with an illustration of a typical cover, a few lines about the journal's aims and readership and, of course, the horrible l.s.d. business, in alphabetical order. The ground covered by English journals is quite astonishing to anybody who has a narrow circle of reading. This column is not mentioned in the blurb about ENGINEERING but then I happen to know that I am kept as the ace up the editor's sleeve. Blooming dark it is up there too, so it's not surprising that some of my stuff is a bit hazy.

The Microcard Foundation (Box 2145, Madison 5, Wisconsin) send me their prices for microcards (in the course of which they use the verb "to microcard"—OED please note) of the National Advisory Committee for Aeronautics Technical Notes 2548 to 4100. I would mention that 2548 to 4100 cost $916, but can be bought in five separate groups.

UNESCO's *Monthly Bulletin on Scientific Documentation and Terminology* (9 Place de Fontenoy, Paris 7e) for December has three and a half pages of recent bibliographies including Soviet military medicine, electrical (sic) shock, fluid power, German motor roads, automatic technology, and one hundred "best" water and sewage books.

Every now and again the boys at 36 Bedford Street unload something French on me with a cryptic "FHS" or "OTS" in the corner to show that I am to mention it. For instance, I have "Statistiques de base de douze pays européens: comparaison avec les États-Unis d'Amerique et l'Union des Republiques Socialistes Sovietiques." This is the deuxiéme edition and as far as I can see it is issued by three Communautés Européennes. Du charbon et de l'acier, haute autorité; economique, la commission; de l'energie atomique, la commission. The dictionary does not help me in the slightest with that "base" bit unless it be "basics" but the booklet is full of terribly useful tables such as consommation de fibres textiles pour habillement (just let me catch my clothing fibres up to any tricks), and production d'aluminium, cuivre, plomb, zinc et étain. There are 90-odd pages of these tables and they do give most useful comparisons in products, agriculture, population, industry, transport, etc.

Those who are interested (and who isn't) in gammagraphie may like to know of "Le controle non destructif des matériaux par gammagraphie," by M. Albert Blondel. This important ouvrage will appear in avril 1959 and if you slap in a subscription by 1 March it will cost 3,000 francs. Forever after it will cost a further 750 francs. Editions techniques des industries de la fonderie at 12 avenue Raphael, Paris 16, are the publishers. M. Blondel is engineer at the direction of the researches of the Centre technical of the industries de la Fonderie. And if you think fonderies have me beat let me tell you they are foundries, casting or melting houses and smeltings.

By the way, if any of you people decide to write to any of the addresses I mention, I wonder if you would point out that you heard of the item through me? This is not from any consideration of vanity or to justify my existence in the eyes of No. 36 but to help you (at least that's my story). Because if distributors of press material know that you read me, they'll send me more dope which will give me more scope for chaff and grain segregation. And don't tell me I mix my metaphors—I know I do.

Research and Development

ELECTRIC TRAIN WHEEL ADHESION STUDIED AT WILLESDEN

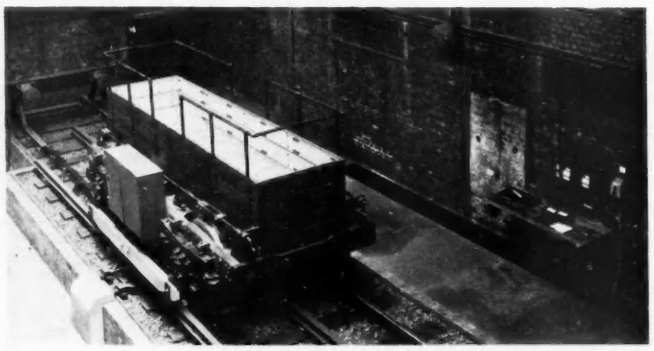
NEW facilities for testing electric locomotives are in use at Willesden. An electrical testing laboratory has been set up there by the British Transport Commission. They point out that it represents "a first phase in arrangements for testing which will be increasingly needed as the first sections of new electrification come into service." In the scope of its work the laboratory (in conjunction with the mobile testing train, whose work it complements) forms a link between the theoretical conclusions of research departments and the practical experience of day-to-day running. High priority has been given to the study of wheel adhesion.

Adhesion between wheel and track has always been an important consideration in the design of locomotives. With electrical traction, however, it assumes greater importance since higher powers can be realised with no corresponding increase in weight. At Willesden the behaviour of electric traction units at very slow speeds can be studied in detail.

The laboratory building formerly housed an electrical sub-station. It now contains a raised length of permanent way, 100 ft long, equipped with third and fourth conductor rails. The vehicle movements are controlled from a gallery. For most experiments measurements can be made on one bogie alone—with additional weights representing the body.

A separate supply of low voltage direct current power, earthed on one side, is provided by two Ward-Leonard sets. It is picked up by shoes on the bogie in the usual manner. As the vehicle is tested at standstill or very slow speeds, full current can be provided without the potential of the conductor rail exceeding about 50 V. Thus the full mechanical and heating effects are obtained at quite a low voltage. In addition, it is possible to raise the track potential to 750 V for tests on track insulation, leakage, etc.

In adhesion experiments, a wooden container, weighted to increase axle loading, is added to the test bogie. It can be seen in the illustration above. Individual hand braking is provided for each pair of wheels, and a group of knife switches on one side of the vehicle enables the two motors to be isolated, or connected individually, in series, or in parallel. Stationary adhesion tests are usually made with the two motors on the bogie in opposition, so that the effects of torque reaction are eliminated; but slow speed tests may be made with one or both motors, the speed of movement being limited by the hand brakes.

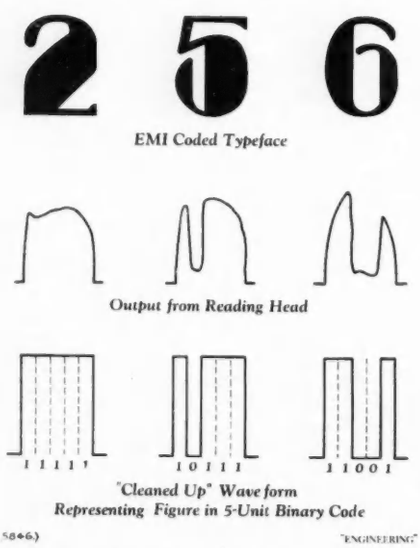


Stationary or slow speed tests are made with single bogie units on the laboratory's 100 ft test track.

The power fed to the bogie is regulated from a control desk, seen on the left, in the gallery of the laboratory.

Other investigations than adhesion studies can also be carried out. Measurements can be made of mechanical, electrical, and heating effects in other forms of traction equipment, including overhead lines and individual items such as motors, conductors, and collector gear. Space has also been left in the installation for equipment likely to be needed in the near future, for example, transformers and rectifiers for providing alternating or direct current power, a motor test bed with automatic controls, or a rack for testing control gear.

TYPEFACE TO SIMPLIFY ELECTRONIC READING


2 5 6
EMI Coded Typeface
Output from Reading Head
1 1 1 1 1
1 0 1 1 1
1 1 0 0 1
"Cleaned Up" Wave form
Representing Figure in 5-Unit Binary Code

The light reflected from the figures is scanned by a vertical slit. The waveform from a photocell behind the slit is then corrected to give a five-unit binary code output representing the numbers.

An electronic "reading" machine was shown recently by EMI Electronics Limited during an exhibition held in their factory at Hayes, Middlesex. FRED (figure reading electronic device), as the device is called, requires its own special typeface, but this disadvantage is largely offset by the simplicity of circuitry that results. The "logic" of the device is relatively simple because the figures are of a form that needs sampling only five times. In contrast, the Solartron Electronic Reading Automaton takes 100 samples, but is able to read a wider range of typefaces and defaced characters.

Although the shapes of the figures suggested by EMI look a little unusual—they are shown in the accompanying drawing—they are by no means as eccentric as some suggested for other character recognition devices. It is clear, however, that at present the wide variety of typefaces used in industry and commerce is a serious obstacle to the widespread use of these machines. A standard international typeface that requires very simple logical circuits for its recognition is urgently needed if the accelerated input to data processing systems that devices such as FRED offer is to be realised.

The five samples used in the EMI system give rise to a 5-unit binary code that can express 16 characters, the first digit in each case always being "1". Thus the Arabic numbers from 0 to 9 will normally be included together with another five optional characters. For example, the figures 10 and 11 in the pence column of an accounts entry could be read as single digits. It is theoretically possible to expand the size of FRED so that it can read alphabetical characters as well; the resulting machine would be ALFRED.

In the present machine, the paper carrying the figures moves past a slit that extends vertically across the full height of the figure. A light illuminates the figures and the reflection from their surface enters the slit to be detected by a photocell. The waveform of the electrical output from the cell varies according to the amount of light reflected from the figure through the slit at any given moment; typical waveforms are shown below the numerals in the drawing (for simplicity the waveforms have been shown as proportional to the amount of black in the slit). Shaping units are then able to "clean up" the waveform from the photocell, producing a 5-unit binary code suitable for recognition by the logic circuits of the machine.

The major part of the circuitry of the experi-

GROWING QUARTZ CRYSTALS

PILOT plant production of synthetic quartz crystals has started at the Merrimack Valley Works, North Andover, Massachusetts, of the Western Electric Company Incorporated. Early development of the hydrothermal process used was carried out by Bell Telephone Laboratories Limited, New York. Crystals up to 3 in in cross section and 6 in long can be grown.

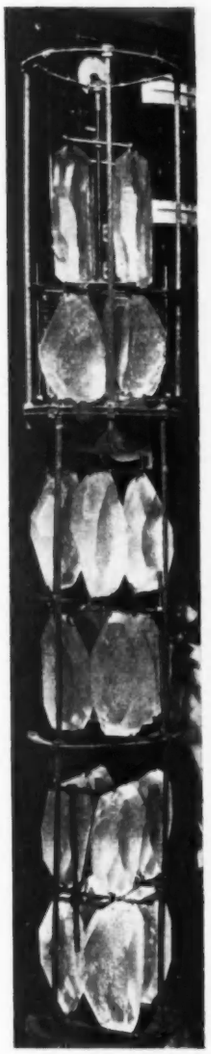
The hydrothermal process relies on the temperature difference in a column of alkaline solution. The " nutrient "—small pieces of readily available natural quartz—dissolves in the hot lower region of the column, giving rise to a supersaturated solution of quartz at the top of the column. Redeposition on to a seed crystal then occurs. The solution is contained in a vertical autoclave, and seed plates, cut from natural quartz or grown crystals, are hung from a rack in the upper section of the vessel. One of the racks is shown on the right.

The autoclave is sealed for a period that varies between one and several weeks, depending on the type of crystals required. During this time a constant temperature differential is maintained. Economical growth rates of more than 0·06 in per day have been achieved. Since growth occurs primarily in one dimension, flat seed plates are used: these grow thicker but change little in other directions. Future production is likely to use high quality sand as the nutrient.

The two companies state that one of the main problems in scaling up the pilot plant equipment was finding a suitable closure for the autoclaves. As can be seen in the illustration, the laboratory vessels were simply welded tubes supported by capped, high pressure piping. A satisfactory closure was developed which gives a tighter seal as the pressure builds up inside. The companies also state that they believe the temperature and pressure conditions to be among most severe encountered in any process industry.

The Bell System, a large user of quartz for filters and oscillators, has been interested in synthetic quartz production for some time—mainly as a result of the increasing difficulty in obtaining large crystals of natural quartz. But synthetic quartz provides a number of advantages in addition to availability in any quantity and size. Seeds can be cut to provide grown crystals that can be sawn in the most efficient manner; the natural crystal faces allow easier orientation of the stock for cutting; and the product has no foreign inclusions, production without optical or electrical twining being possible. It is estimated that the greater yield resulting from these improvements is at present 2·5 times that of natural quartz.

The experimental vessel held in the hand can be compared with the portion of the pilot production autoclave visible in the foreground.



A group of quartz crystals in the autoclave rack in which they are grown.

Concluding

Typeface to Simplify Electronic Reading

mental model shown was made up from standard printed circuit boards used in the company's EMIDEC digital computer, a direct-coupled transistor-diode logic being used. The logic recognises a character in about 8 microseconds, and if it were not for the mechanical problem of handling paper at high speeds, FRED could read at 100,000 characters per second. The model displayed operated at 300 characters per second, and it is expected that a speed of 10,000 characters per second will be possible. The difficulties of handling the paper are lessened by the fact that the characters are read by moving them smoothly past the reading head; there is no need to bring them to rest or to centralise them. Where continuous rolls of figures have to be scanned it is convenient to move the paper and keep the head stationary. The same is true when the characters are on the side of packing cases or railway trucks. Alternatively, a slit image can be projected on to the characters and moved optically over the stationary paper. This is of particular use where columns of figures have to be read.

HYPERSONIC WIND TUNNEL

18,000 m.p.h. Airflow

A wind tunnel, which will test models at the speed of satellite rockets, is expected to be in use in the United States toward the end of this year. To be built by the Boeing Airplane Company, it will become their fourth hypersonic (above Mach 5) wind tunnel and they say it will enable them to test large models at higher speeds than any other firm in the field of space flight.

Known as a " hotshot " tunnel, it makes use of a powerful electric arc to pressurise the air instead of the more usual compressor pumps. The arc chamber is pressurised to 2,000 lb per sq. in and is joined to the test section by a conical nozzle with a tungsten throat. When the test section has been pumped down to vacuum, a current of up to 5 million amperes is discharged for 2 milliseconds into the steel arc chamber.

This powerful charge boosts the pressure in the chamber to 30,000 lb per sq. in and the temperature reaches 25,000° F. The high temperature than melts a plastic diaphragm used to seal off the tungsten throat.

The size of the throat determines the speed of the air through the test chamber. In the case of a Mach 26 test, the throat is the size of a small pin-hole. In fact the upper limit to the air flow speed obtainable is mainly dependent upon how small a hole can be drilled in a block of tungsten.

When the tunnel throat is opened by the arc discharge a shock wave passes down the 23 ft long nozzle and test chamber, followed by a hypersonic flow of air. The shock wave then bounces off the end of the tunnel and destroys the hypersonic flow.

The effect of the returning shock wave is to limit the time of the test to 1/25th of a second. However, during that time 36 channels of information will have been collecting data at ultra high speeds, on the test model's reaction.

A 1/5th scale pilot hotshot tunnel has been in operation at Boeing for several months to check the techniques, and some of the components, to be used in the full-scale model.

Construction

BUILDINGS FOR IRON AND STEELWORKS

Their Design and Construction discussed at BISRA Conference

CIVIL and structural difficulties in the design, construction and maintenance of buildings for iron and steelworks were discussed recently at a conference organised by the Plant Engineering and Energy Division of the British Iron and Steel Research Association. Current research on civil and structural engineering being carried out by BISRA was outlined in several papers. Other papers gave details of modern French, German and American practices. The final paper discussed the architecture of such buildings.

The conference, entitled "Iron and Steelworks Buildings," was held at Ashorne Hill, Leamington Spa, on 14 and 15 January, under the chairmanship of Mr. R. L. Willott, D.S.O., O.B.E., chief engineer of John Summers and Sons Limited. The chairman opened the conference by remarking that it was the first to be held on this subject for some years and he extended a particularly warm welcome to the delegates from France and Germany.

Foundations for a Melting Shop for the South Durham Steel and Iron Company.

BELOW GROUND LEVEL

The first paper, "Foundations to Iron and Steel Works Buildings," by Mr. W. S. Atkins, presented by Mr. K. N. Drobig of W. S. Atkins and Partners, drew attention to the short time usually available between the final agreement on the plant to be installed in new building and the starting date for laying the foundations. For this reason the paper recommended laying the foundations in two stages, the plant foundations following those of the superstructure. The advantages of a thorough preliminary investigation of the site and interpretation of the results were emphasised, as was the relatively greater importance of differential settlement of buildings compared with total settlement. The paper dealt in detail with some particular problems of design, an example of the planning and management of a contract, the choice of the best form of contract, and the desirability of some form of cost control.

This general paper was followed by one entitled "Some Notes on Iron and Steel Works Buildings at Corby Works," by Mr. T. E. Clements, and presented by Mr. J. T. E. Williams of Stewarts and Lloyds Limited, Corby. Details were given of the difficulties encountered at Corby arising from a site comprising natural ground, backfill and the levelled remains of a slag heap, including the foundations of old blast furnaces. Design details of the six different types of piles used were explained, including methods of strengthening and stabilising the piles.

In the discussion on different forms of contract, Mr. Drobig agreed that a scheduled rates contract should be selected if the details of the work had been decided, but in other cases the target type of contract was preferable. One speaker pointed out that, on a recent job, a target type of contract had saved over 5 per cent compared with a negotiated contract. Mr. Williams favoured a lump sum contract with variations included as quotations from the contractor, making them effectively extra lump sum orders. It was generally agreed that it would be most useful if steelworks kept a full record of foundations laid and of their expected and actual behaviour.

SUPERSTRUCTURE

The following session comprised two papers, "Some Notes on Modern Steelworks Structures," by Mr. E. F. Wooldridge and Mr. N. Lancaster, both of United Steel Companies Limited, and "Load Distribution through Melting Shop Stage and Gantry Rail Maintenance," by Mr. D. B. Wilson (the Steel Company of Wales). The first of these dealt with the design and construction of building structures covering a wide range of steelworks requirements, and reviewed the form of construction in relation to the fundamental needs of an electric melting shop and a medium-width hot strip mill, and also dealt with the reconstruction of a billet mill building, without stopping production, on a completely surrounded site. Introducing this paper, Mr. Wooldridge pointed out the merits of transverse high/low roof design, especially with the present trend to wider spans and multi-bay buildings. In particular, such design gives good maintenance access.

The second of these two papers outlined investigations made on the strength of an existing melting shop stage when it was decided to use a crawler-mounted machine on it for demolishing the roofs and walls of open-hearth furnaces. Details of the positioning of electrical resistance strain gauges and the results obtained were given. The second half of the paper, on crane gantry rails and fixings, detailed the advantages of rail lubrication, a method of reducing standard 144 lb per yd to 118 lb per yd rail section (which is no longer rolled), the merits of welding rail joints and the welding procedure used, and details of the two types of rail clips used in the works of the Steel Company of Wales.

In the discussion, criticism of the high/low roof design was answered by Mr. Lancaster. He pointed out that, with the proper positioning of light clusters, the new design more than paid for itself on maintenance savings alone. On the choice of high strength bolts or rivets, Mr. Wooldridge said that at the moment high strength bolts were being used in steel structures and were replacing rivets on a basis of one for one. This meant that the safety factor increased three times, which was uneconomical and new designs to reduce this waste, giving some saving in cost, would no doubt soon be undertaken. It appeared from the discussion that resilient pads were being used to reduce wear on rails and wheels but in most works they were used on rails with light loadings.

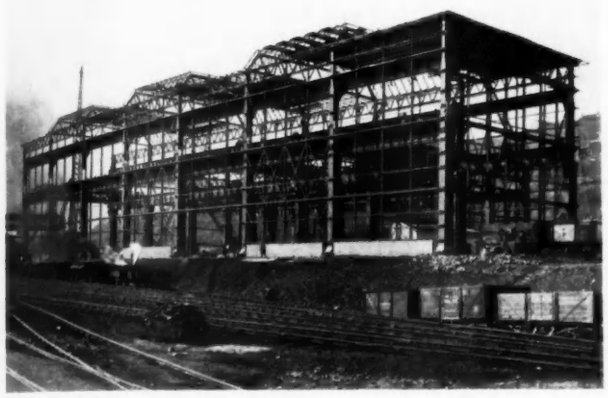
The next session comprised two papers, "Superstructures to Iron and Steel Works Buildings," by Mr. K. F. Geesin, of Colville Construction Company Limited, and "Iron and Steel Works Buildings," by Mr. E. Ibbotson, of Dorman Long (Bridge and Engineering) Limited.

The first of these two papers presented some of the problems which occur in the planning, design and construction of modern steel works and described the types of superstructure employed in the integrated iron and steel works built by Colvilles at Ravenscraig.

Mr. Ibbotson read a general paper on trends in design of steel works buildings since the war. He detailed the factors influencing the decisions which must be made in the early stages of planning and those features which have a large effect on the ultimate cost of the structure and therefore need special consideration, including the use of special steels and the

heavy structural shapes now available. The paper also considered the relative economic merits of riveting, welding, and the use of high strength bolts and the merits of different types of crane gantry rail clips.

In the ensuing discussion, the lighting and ventilation system at Ravenscraig, using electrically-operated roof louvres, was described in detail and Mr. Geesin claimed that the arrangements worked satisfactorily. The system required very little maintenance and the louvre angle could be adjusted so that the roof was sufficiently weatherproof for any given direction and intensity of rain. Even when the louvres were fully closed the jack roof gave sufficient ventilation for the prevailing weather conditions. Other speakers agreed that the difficulty of cleaning even vertical glazing made the louvres method of illumination preferable, though there were objections that it had not been found easy to maintain wall louvres in a working condition. It was suggested that guttering was



Framework for an Electric Melting Shop for the United Steel Companies.

unnecessary and its removal would assist the natural cleaning of vertical glazing by rainwater as at Durgapur.

On being asked for his views on the high/low versus the pitched roof design for a melting shop, Mr. Ibbotson said that Dorman Long use a Mansard roof on all their steelworks buildings. This was because the glazing was self-cleaning in the mill shops, though it did require some maintenance in the melting shops. A speaker from the floor agreed, saying that on a recently constructed electric arc melting shop a Mansard roof was decided upon because it provided an air space above the gantry girder which acted as a sump for fumes. The discussion ended with the suggestion that steelworks buildings which were kept permanently warm were in no need of painting or other surface maintenance to resist corrosion. Examples of buildings which had remained unpainted for some time, but were still in perfectly good surface condition, were given but it was concluded that a good reason for painting the inside of the buildings would be its effect on morale.

FOREIGN PRACTICE

The fourth session of the conference consisted of papers on Continental and American practices. The first paper of the session, entitled "The Framework of Buildings used in the Iron and Steel Industries in France," was by A. Delcamp, and presented by Mr. H. Lepeu of the Chambre Syndicale Construction Métallique, France. It was followed by "Examples of Iron and Steelworks Buildings in Germany," by Dr. G. F. Drath of Fried. Krupp Industriebau, Germany.

M. Lepeu discussed the challenge to structural steel offered by reinforced concrete construction and said that research into design methods was desirable. He commented that completely welding the structural steelwork of a building and extensive welding on site were both undesirable and that pre-welding structural members has many advantages. Dr. Drath's paper gave examples of all types of iron and steelworks buildings from Europe, India, the Far East and America.

In the short discussion which followed these papers, the use in crane bogies of vertical flangeless wheels and horizontal locating rollers to relieve wear on rails and wheels was discussed. The present German code of practice on high strength bolts, which also gives a guide to a choice of steels for various uses, was recommended.

The paper "Research and Development in Relation to Buildings and Structures in the Iron and Steel Industry," by Dr. J. S. Terrington, Mr. D. Buchanan and Mr. P. D. Thompson, all of BISRA, was introduced by Dr. Terrington.

The paper began with a survey of general design considerations, such as the ultimate objective of design (fitness for purpose, amenities, etc.), the selection of materials, and the means of assessing the life of the structure and its factor of safety. Then followed a review of current trends in design. The last two sections of the paper described recent, current, and possible future research. Work by BISRA on structures had centred largely on problems found in steel frameworks. In particular, a programme of stress measurement had been carried out on electric overhead travelling cranes and gantry girders under operational conditions. The results had been used in the BISRA Heavy Duty Crane Specification, now being used as a basis for the new British Standard, and in determining modified dynamic load factors for gantries. Long-term measurements, to obtain the stress pattern in relation to the effects of fatigue, were also being made. The effects of vibration in foundations and the characteristics of anti-vibration mountings were also being measured. For structures statically loaded, improved frames had been suggested and a reliable method of analysing beams and girders subject to twist had been evolved. Reference was made to tests on steelworks structures to assess their margin of strength to permit higher throughputs without the expense of strengthening members. Numerous proposals for future research were made in the paper and the members of the Conference were invited to indicate topics for future research.

Electrically operated roof ventilation and lighting shutters at the Ravenscraig works of Colvilles.

In the subsequent discussion, speakers suggested the following topics for research: thermal insulation; the fatigue strength of high tensile steel, which might be included in general research into connections; and the structural effects of continuous severe vibrations imposed by running machinery. The chairman suggested that more research should be undertaken into the structural possibilities of broad flange beams and the relative costs and appropriate uses of different types of building construction. Dr. Terrington replied that, apart from projects undertaken as part of their general research programme, BISRA could and did undertake to investigate a certain number of problems for individual member companies on a contractual basis.

The final paper presented at the conference was "Architectural Aspects of Iron and Steel Works Buildings," by Mr. F. Gibberd, C.B.E., F.R.I.B.A. Mr. Gibberd began with a consideration of the siting of iron and steelworks, pointing out that as the buildings will always dominate the landscape, and are out of scale with residential dwellings, they should always be separated from towns, with their associated light industries, by a belt of purely agricultural land.

The final session of the conference consisted of a short summary by Mr. Gibberd of the work of the conference and the more important ideas which had been put forward. In his general closing remarks he approved of the programme arrangement by which each session consisted of two papers, one containing general considerations of a topic and the other a description of the practical applications in a specific case.

Production

CONTROLLED SHOT PEENING

Shot peening is an accepted method of work hardening component surfaces to improve fatigue properties, but it is often inapplicable because it mars the component surface and may also cause dimensional changes. The method described here enables the peening to be controlled.*

The basic principle is shown in Fig. 1, while Fig. 2 indicates diagrammatically typical applications to external and internal work. As will be seen from the sketches, the peening tool consists of a disc, mounted in a manner similar to a grinding wheel, and having at its periphery a number of steel balls which are so held in a cage that they can be flung outwards to a limited extent by centrifugal force, but cannot fall out altogether. As the tool is rotated and fed across the surface of a rotating component, the balls hit the component surface and cause plastic deformation. In addition to the actual striking effect, the pressing of the balls against the component by centrifugal force assists in the peening action.

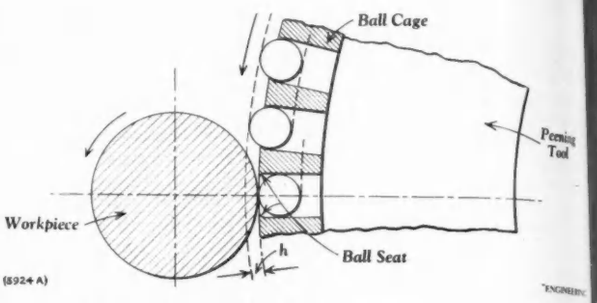


Fig. 1 Diagram showing principle.

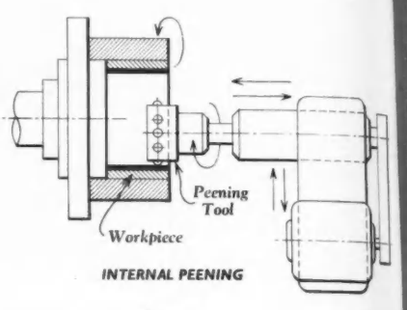
Rollers can be employed instead of balls, and the peening tools can be of many different designs; they may, for example, have the proportions of reamers, instead of being disc-shaped. Oil-resisting rubber bands can be inserted under the balls or rollers so that when they fly inwards after hitting the work they are braked gently and noise is reduced.

The most important part of the tool is the ball cage, which is made of carbon steel and heat treated to a hardness of 37 to 41 Rockwell C. It can be made by first drilling the holes undersize and then forming the ball seating by reverse countersinking, or it can be reverse bored to the correct form. Uniformity of seat depth is important, and this should be checked by means of a ball and a dial gauge. If the tools are made carefully and accurately they should give long life; it is reported that after five years of continuous use in the USSR no tool failures have occurred.

CONTROL IN USE

Components to be peened must have good surface finishes and be made to close dimensional tolerances. They should be degreased and have no rust stains. True running of round components is important, permissible errors for both internal and external work being not more than 0·001 in. Both the tool and the workpiece should be lubricated frequently with light oil.

The peening operation is adjusted according to the required properties of the component surface, the work-hardening behaviour of the material being taken into account. The actual depth of the work-hardened layer can be adjusted by varying the preloading distance (" h ", Fig. 1), which should not, however, exceed 0·012 in for ¼ in diameter balls. Tool surface speeds depend on the material of the workpiece. For a heat-treated steel of 450 Vickers Pyramid hardness a speed of 120 ft per sec is required. Softer steels are peened at 40 to 80 ft per sec, cast irons at 45 to 60 ft per sec, and non-ferrous alloys at 25 to 40 ft per sec. In peening circular components, the axial feed is 0·008 in to 0·08 in per revolution of the workpiece, and the workpiece surface speed 90 to 270 ft per min.



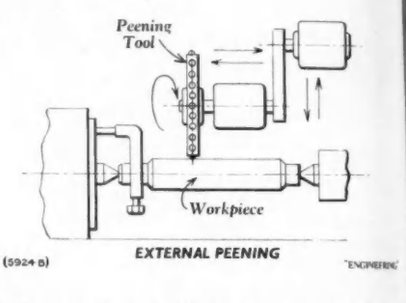


Fig. 2 Typical arrangements for internal and external peening.

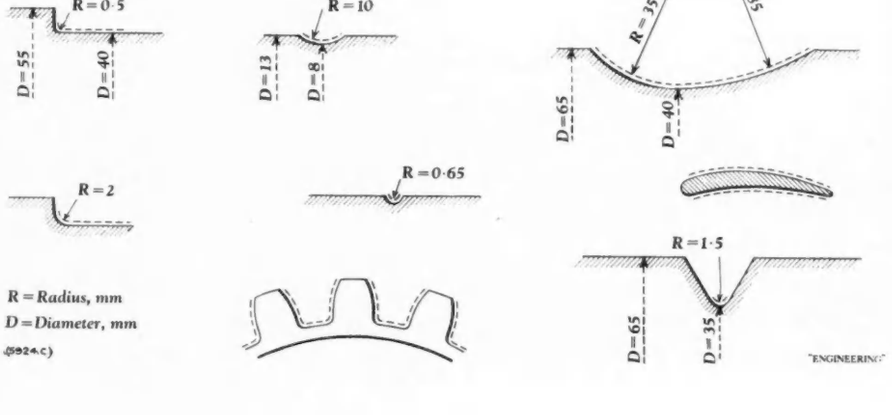
Controlled shot peening gives a total number of impacts varying between 12 and 70 per sq. mm of surface area (7,500 to 44,000 per sq. in), and the amount of work hardening varies accordingly. It is possible to cover up to 80 sq. in per min, and the number of impacts is up to 1 million in the same period of time.

If the surface roughness of the unpeened components is not worse than 30 micro-inches the variations in diameter caused by peening are not over ± 0·00008 in. With a surface roughness of approximately 100 micro-inches the variations after peening are still small, being no more than ± 0·0005 in. Since such variations are generally within the acceptable limits of the components it can safely be assumed that for all practical purposes controlled shot peening does not cause dimensional changes.

The method is not confined to circular-shaped components, many different non-circular shapes can be peened, and the geometrical accuracy of the finished work will be maintained. A few typical non-circular applications are shown in Fig. 3.

* The material on which this article is based appeared originally in the Russian book, *Increasing Wear Resistance and Life of Machine Parts*, published by Mashgiz in 1956 ; this article was prepared from the original by Dr. M. M. Barash and Dr. P. L. B. Oxley, who are both at the Manchester College of Science and Technology.

Fig. 3 Examples of non-circular work amenable to the described method of shot peening.



FASTER PIPE WELDING ON SITE

To speed up pipe laying, Quasi-Arc Limited, Bilston, Staffordshire, have introduced a new manipulator for welding the pipes in pairs before they are laid. The manipulator, which will handle pipes up to 40 ft long in pairs, can be used with any of the normal Quasi-Arc automatic welding processes. To accommodate pipes of different diameters, the welding head is fully adjustable on the vertical column of the machine.

In operation, the manipulator accepts the pair of pipes on a cradle fitted with rollers and rotates the pipes under the welding head, in much the same way as the roller-beds used for large vessels. Handling of pipes on and off the bed is done hydraulically, and adjustable-speed driving rolls are provided over the whole bed length.

The manipulator is specially designed to give consistent alignment under the welding head, and as it is a completely self-contained unit it can be used equally well in the shop or on site. Engine-driven equipment provides a.c. power operation of the rollers and d.c. supply for welding and ancillaries.

Operation and Maintenance

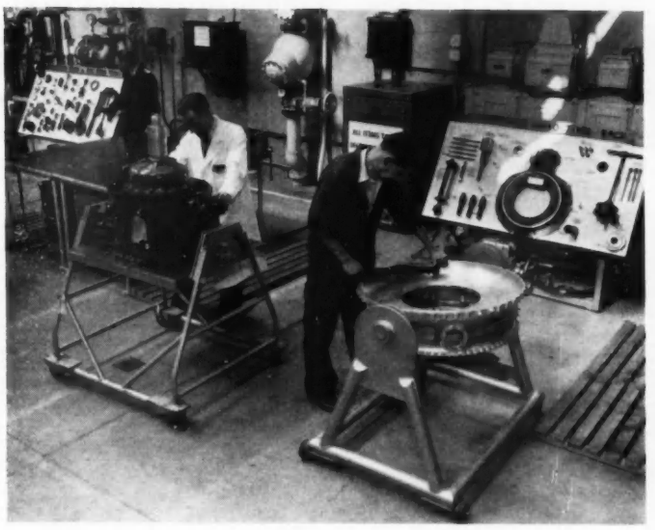
MAINTAINING BEA DARTS

Overhaul Facilities for Rolls-Royce Turboprop Engines

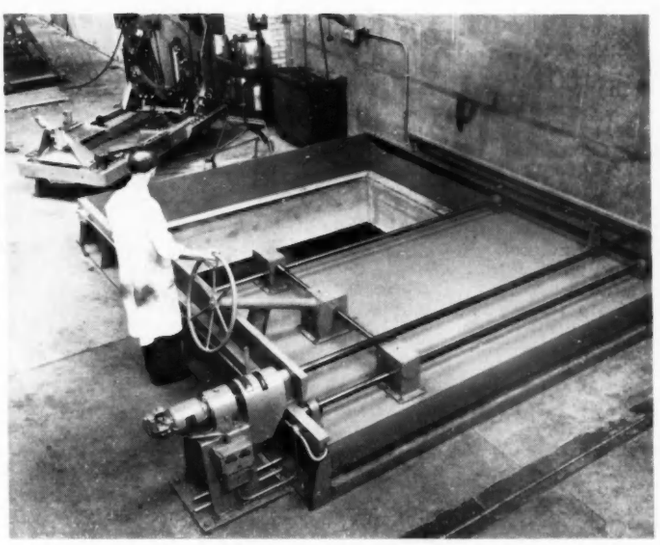
With more than 250 Rolls-Royce "Dart" turboprop aero engines in service, British European Airways now have more gas turbines in use than any other airline in the world. After a specified number of hours in service—2,200 in the case of the Dart 506, for example—the engines are withdrawn from operation, stripped, inspected, overhauled and tested ready for use again. It has been the practice up to now to send the engines to distant overhaul factories but BEA, are now carrying out overhaul and testing of Darts on an experimental basis in a new shop at their engineering base adjoining London Airport.

New hangars and workshops being built nearby will give greatly increased overhaul facilities and will make it possible to deal with other engines besides the Dart. Meanwhile the experimental equipment is not only being used for routine engine overhaul but is also providing practical experience for BEA engineering staff.

An engine to be stripped is mounted on a specially-designed stand, which has power rotation about the lateral axis and can be rotated manually about the longitudinal axis. These stands, which are also used for re-assembly purposes, give maximum accessibility to the engines, and enable the operators to position the work so that they can reach it comfortably from floor level.



At the BEA engineering base the special tools needed for Dart engine overhaul are kept on racks adjacent to the assembly stands.



The first step in dismantling an engine is to break it down into five main assemblies, an overhead electric hoist being provided for removing these items to bench level, where they are stripped down to their individual components. Dismantled parts are taken to the adjacent cleaning bay, which is equipped for kerosine washing and trichlorethylene vapour degreasing. Parts are then inspected, sent for rectification as required, and pass to the assembly section, where the sub-assemblies and complete engines are built up.

Limited life-terms are laid down for a small number of components, but most of the remainder will be suitable for re-use, and an adjoining salvage area is equipped to provide whatever treatment inspection shows to be necessary. Most of the machines in this part of the shop are of the general-purpose type, but special fixtures are used in some cases. An example of special adaptation is provided by an Argonarc welding unit which is equipped for salvaging Dart turbine blades and combustion chambers.

For re-assembly the shop is equipped with special stands and fixtures including, for the complete engine, the power and manually rotated stand already mentioned. Full use is also made in the assembly section of a feature which is common throughout the shop—special tool display racks. Numerous special tools are needed and BEA have adopted the display racks as a means of placing the tools where they are always accessible to the workers. Tool racks are located at each dismantling, sub-assembly and final assembly point, and it has been found in practice that they are appreciated by the operators, who use them as valuable time-savers.

One of the main features of the overhaul shop is the test plant, where re-assembled engines undergo testing to a rigorous schedule. This test plant, which was designed and built by Heenan and Froude Limited, Worcester, in close collaboration with BEA, has some unusual features. It is placed in an underground cell to save space, and particular care has been taken to ensure that engines can be placed on test and removed in the absolute minimum of time.

With this requirement in view two engine carts have been designed one of which is normally in use on the test bed while the other is in the overhaul shop above having an engine fitted to it. By this means the necessary electrical harness, piping, adaptors and other items, can be fitted to the engine before it enters the test cell.

When an engine is assembled and ready for test, the cell cover, which is motorised, is run sideways to give access to the cell, and the assembled cart, complete with engine, is

Engines are finally assembled on the test cart seen in the background, and lowered through the shop floor to the test cell below.

In the test cell a Heenan and Froude dynamometer provides and measures the load. A separate small dynamometer enables the engine auxiliary drive to be loaded.

Continuing

Operation and Maintenance

lifted by an overhead electric hoist and lowered into the cell. Outrigger guides on the hoisting sling protect the engine from damage in the unlikely event of its hitting the sides of the floor aperture as it passes through. As soon as the engine is in position, the sling is raised and the test cell door can be closed. Very effective sound proofing has been achieved by arranging the door rollers on eccentrics so that the complete door can be lowered on to thick felt pads.

AUTO LOCATION AND COUPLING

There are two compartments in the test cell, one for the actual test equipment, and the other for the control room. When the engine is lowered into position it is located automatically by dowels, the accuracy being such that the pipe connections on the cart engage with matching self-sealing connections on the base plate. All the pipe connections for oil, water-methanol and fuel are thus made automatically, and it only remains to lock the cart in position and connect the engine to the dynamometer and operating controls.

A tubular cardan shaft is used to couple the engine to the dynamometer, a Heenan-Dynamatic Mark VI eddy current machine capable of absorbing and measuring up to 2,500 b.h.p. Loading of the accessory drive on the engine is achieved by means of a small Heenan and Froude hydraulic dynamometer carried on an accessory trolley.

An exceptionally good view of the test bed is obtained through the observation window of the control room, in which the controls and instruments are grouped in the usual manner. A large mirror in the test room enables the far side of the engine to be observed. Gauges fixed behind glass enable the rate of fuel consumption to be seen clearly, but no fuel pipes run through the control room itself. Safety precautions throughout are to a very high standard.

FUME SCAVENGING

Exhaust gases are taken through a soundproofed uptake to the roof of the building where they are discharged into the atmosphere. A similar duct is used for the main air intake, and electro-pneumatic rams are provided to close this intake in case of fire. Walter Kidde CO_2 and Mather and Platt " Protectospray " equipments are provided in the test cell, and the floor trenches are continuously scavenged by a fan and ducting to remove fumes. This extraction plant is interlocked to prevent fuel from being supplied for testing until the scavenging has been in operation for 20 minutes from a shut-down condition. The main fuel tanks are outside the building.

A block isolated by 2 in Coresil cork from the rest of the building carries the actual test assembly, and the walls of the dynamometer cell are lined with 2 in rock wool packing in a timber lattice, covered by perforated galvanised sheeting.

The two Heenan and Froude test beds to be incorporated in the new extension to the Engineering Base will be situated above ground, unlike the present installation. In addition to Dart engines these beds will also be capable of testing the larger Tynes which will be used to power BEA's fleet of twenty Vanguards.

Engineering at Home

ENGINEERED CAMPING EQUIPMENT

A transformation has taken place in the design of camping equipment since the war. Compared with the wood, canvas and rope contraptions which used to make camping an exercise in spartan endurance, the best modern equipment is thoroughly engineered in design and production.

Continental manufacturers, especially French firms, were the first to show initiative. In Italy and southern France sunshine throughout the summer holidays is a near-certainty; there is little risk of the holiday being ruined by the weather. If, therefore, the woman of the party can be given equipment which is almost as efficient, clean and convenient as her own kitchen, the whole family can happily spend a few weeks at a modest cost and with none of the irksome restrictions which spoil a hotel or boarding house holiday.

The Marechal tent, made in France and imported into most European countries (including Britain), is a first-class production. Adults can stand up in it comfortably, it is easy to erect, it is very compact when bagged for travelling, and when erected it requires virtually no attention in wind or rain. The frame is made of light steel tubes. The various lengths of tube are arranged in groups, each group consisting of about four tubes pivotted to a pressed star-shaped piece so that they can be folded together for packing and opened out on the camp site for erecting. This system also eliminates confusion in sorting out the bits and pieces, and thus saves time.

In most models there are only two guys, and these are made of rubber, about $\frac{1}{4}$ in square section, so that they give with the effects of wind and rain. Some of these guys, instead of being straight, are zig-zagged along their length to provide additional elasticity. The " floor " space is divided into two parts—the sleeping part and the kitchen. The former is an inner tent with the groundsheet sewn into the walls so that water on the ground after rain cannot enter. The kitchen is a more open space with an awning, and zip fasteners are used wherever possible to open and close the tent openings. Even tent pegs today are improved: there are several types to suit different sorts of ground, and the bottom edge of the tent wall is fastened to them simply by short rubber loops.

The fussy messiness of camp cooking has been eliminated by the Bleuet stove, which is also a French development (ENGNG., vol. 183, 195[illegible] p. 533). The fuel is butane, supplied in seve[illegible] standard sizes of throw-away or refillable me[illegible] containers and sold at thousands of garages [illegible] France under the trade name of Camping Ga[illegible] It is expected to be marketed in Britain th[illegible] summer at most Shell and BP garages. Th[illegible] stoves are a first-class engineering job. They a[illegible] foolproof, require no priming and create no dir[illegible] Accessories include a lamp and a heatin[illegible] reflector.

Canvas water carriers are giving way to polythene containers. Small models, carrying up to a gallon, are available in collapsible form for packing in the car, and various rigid designs include one on " jerrican " lines. A special version is made for carrying petrol.

A German firm have developed a combined table and four seats in one unit which folds up as a compact assembly, and there are several very trim camp chairs of light alloy. The design of such an apparently simple piece of camp furniture as a table has been indifferently considered in the past, but Continental makers have managed to produce designs of normal table height, convenient to use and stow.

A camp bed with a frame of light tubes can also be used as a chair (with arm rests) or arranged in a reclining position for sunbathing. Climbing equipment is more conservative—for obvious reasons—but now nylon ropes do not rot or weigh heavily when wet, and special rubber soles have largely replaced the traditional leather with climbing nails.

It is estimated that in this country more than 300,000 families take camping holidays. Many of them cross to the Continent where they can be sure of the weather. But there are still about two million families each year who go without a holiday. The interest aroused by the first Camping Exhibition recently held in London may suggest a solution to some of them, and last week a new camping store, where the full range of modern gear is displayed, was opened at 14 Holborn, London, EC1, by Fry and Cowell (Pindisports) Limited, a firm who have introduced many of the continental items to Britain. They supply a catalogue describing the range of equipment, including the items mentioned in this article.

POWERED JIG-SAW

Latest in the range of powered tools for the home craftsman is the new Black and Decker U.10 electric " jig-saw."

It is claimed that, by interchanging blades, it will cut through wood, plywood, metal, leather, and various types of composition material, and will cut curves of small radius or follow intricate patterns with ease.

Its optimum load rating is $\frac{1}{2}$ in softwood or $\frac{3}{8}$ in hardwood. However, its maximum rating (not recommended for continuous operation) is $1\frac{1}{2}$ in softwood or 1 in hardwood.

On no-load it runs at 3,750 strokes per minute and it will work from standard a.c. or d.c. voltages.

Further information from Black and Decker Limited, Harmondsworth, Middlesex.

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